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# THESIS

**RETENTION ELASTICITY AND PROJECTION MODEL FOR U.S. NAVY MEDICAL CORPS OFFICERS**

by

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March 2013

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Retaining skilled doctors in the Navy's Medical Corps has become increasingly difficult due to the Global War on Terrorism (GWOT) and lucrative positions outside the military. This thesis estimates probit models to evaluate the effect that the civilian-military pay gap has on the overall Medical Corps retention rate across 19 specialties using data gathered from Bureau of Medicine and Surgery and Medical Group Management Association for Fiscal Year (FY) 2002 to FY2011. In particular, this study measures the overall retention elasticity and elasticity estimates for three main specialty groups (primary care, surgical specialties, and other specialties) and 19 individual specialties. Furthermore, projection models are employed to predict the Medical Corps' future retention rates. Finally, this study seeks to understand if the protracted GWOT has an effect on the retention behavior of the Navy's Medical Corps.

The results indicate that a 1% increase in the pay gap reduces the overall retention probability by 0.24%. The surgical group shows the highest retention elasticity (–0.31), while the other specialties group exhibits the least responsiveness (–0.19). The projection models estimate that the aggregate retention probability for FY2012 will be one percentage point lower than the actual retention rate of FY2011 (58%). Finally, the prolonged GWOT has reduced the overall retention rate by 14.1 percentage points.


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# ABSTRACT

Retaining skilled doctors in the Navy's Medical Corps has become increasingly difficult due to the Global War on Terrorism (GWOT) and lucrative positions outside the military. This thesis estimates probit models to evaluate the effect that the civilian-military pay gap has on the overall Medical Corps retention rate across 19 specialties using data gathered from Bureau of Medicine and Surgery and Medical Group Management Association for Fiscal Year (FY) 2002 to FY2011. In particular, this study measures the overall retention elasticity and elasticity estimates for three main specialty groups (primary care, surgical specialties, and other specialties) and 19 individual specialties. Furthermore, projection models are employed to predict the Medical Corps' future retention rates. Finally, this study seeks to understand if the protracted GWOT has an effect on the retention behavior of the Navy's Medical Corps.

The results indicate that a 1% increase in the pay gap reduces the overall retention probability by 0.24%. The surgical group shows the highest retention elasticity (–0.31), while the other specialties group exhibits the least responsiveness (–0.19). The projection models estimate that the aggregate retention probability for FY2012 will be one percentage point lower than the actual retention rate of FY2011 (58%). Finally, the prolonged GWOT has reduced the overall retention rate by 14.1 percentage points.

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AAMC | Association of American Medical Colleges |
| ACF | Autocorrelation Function |
| ADBD | Active Duty Base Date |
| ADO | Active Duty Obligation |
| AF | Air Force |
| AFHPSP | Armed Forces Health Professions Scholarship Program |
| ASP | Additional Special Pay |
| AVF | All Volunteer Force |
| BAH | Basic Allowance for Housing |
| BAS | Basic Allowance for Subsistence |
| BCP | Board Certified Pay |
| BUMED | Bureau of Medicine and Surgery |
| BUMIS | Bureau of Medicine Information System |
| CAPT | Captain |
| CBA | Cost-Benefit Analysis |
| CDR | Commander |
| CNA | Center for Naval Analyses |
| DA | Direct Accession |
| DFAS | Defense Finance and Accounting Service |
| DMDC | Defense Manpower Data Center |
| DoD | Department of Defense |
| DODFMR | Department of Defense Financial Management Regulation |
| FAP | Financial Assistance Program |
| FY | Fiscal Year |
| GMO | General Medical Officer |
| GWOT | Global War on Terrorism |
| HMPDS | Health Manpower Personnel Data System |
| HPLRP | Health Professions Loan Repayment Program |

| | |
|---|---|
| HPSP | Health Professions Scholarship Program |
| HSCP | Health Services Collegiate Program |
| ISP | Incentive Special Pay |
| LCDR | Lieutenant Commander |
| LT | Lieutenant |
| MAD | Mean Absolute Deviation |
| MAPE | Mean Absolute Percent Error |
| MC | Medical Corps |
| MGMA | Medical Group Management Association |
| MSC | Medical Service Corps |
| MSE | Mean Squared Error |
| MSP | Multiyear Special Pay |
| MTF | Military Treatment Facility |
| NAVADMIN | Navy Administrative Message |
| NAVMED | Navy Medicine |
| OB/GYN | Obstetrics and Gynecology |
| OEF | Operation Enduring Freedom |
| OIF | Operation Iraqi Freedom |
| OLS | Ordinary Least Squares |
| OPNAV | Office of the Chief of Naval Operations |
| OPTEMPO | Operation Tempo |
| OSD | Obligated Service Date |
| PACF | Partial Autocorrelation Function |
| RMC | Regular Military Compensation |
| SRB | Selective Reenlistment Bonus |
| UIC | Unit Identification Code |
| USMC | United States Marine Corps |
| USUHS | Uniformed Services University of the Health Sciences |
| VSP | Variable Special Pay |
| YOS | Year of Service |

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# I. INTRODUCTION

Navy Medicine is an essential aspect and a vital component of the United States Navy. Its mission statement reads: "We enable readiness, wellness, and healthcare to Sailors, Marines, their families, and all others entrusted to us worldwide be it on land or at sea (Bureau of Medicine and Surgery, 2013)." In order to achieve its mission, the Navy's Bureau of Medicine and Surgery (BUMED) has to meet certain manpower requirements. In the last 10 years, due to the Global War on Terrorism (GWOT) and the country's economic recession, there has been an increased concern about BUMED's ability to meet its manning requirements, and thus the ability to maintain BUMED's recommended manning level of fully trained and experienced physicians. An inadequate number of medical personnel would not only threaten the Navy's ability to meet its mission, but it would also affect the Navy with low retention rates and high manpower turnover.

Retaining skilled and qualified employees is one of the foremost challenges that all organizations share, including the military, for many reasons. Organizations that face a high turnover rate incur high costs when recruiting qualified applicants to fill the vacancies and additional costs to train these new employees. Second, the cost of productivity loss and degraded readiness, as a result of high attrition, is inestimable, but existent (Weiss et al., 2003). Indeed, attrition in the military is more problematic than in civilian organizations: mainly, in occupations where a civilian-military pay gap exists and when the economy is thriving (Weiss et al., 2003). Military physicians who face a positive, growing gap between military and civilian compensation are more likely to pursue an increasingly attractive civilian career, especially since their skills and qualifications are easily transferable. In addition, because of the existing short supply of physicians in the civilian market and the high cost of recruiting and training new physicians to become specialists, the civilian sector competes to attract fully trained military physicians by offering higher compensation and greater job stability. This greatly

affects military physicians' retention rates, contributes to an increased turnover of unobligated healthcare specialists, and puts stress on the military's personnel planning to retain these specialists.

A physician's decision to stay in or leave the Navy after serving his or her initial active duty obligation (ADO) is influenced by many factors such as working conditions, military lifestyle, and/or financial compensation (Shepherd, 2001). The GWOT, which caused an increase in operation tempo (OPTEMPO), has affected the providers' lifestyle with increased deployments compared to the pre-GWOT period. Since financial compensation and individual lifestyle has a significant influence on the healthcare provider's decision to stay in or leave the Navy, this can significantly impact Navy providers who decide to remain in the Navy. This will increase their clinical workload and level of stress in order to compensate for those who left. Military providers receive various types of pays.

All Navy personnel receive Regular Military Compensation (RMC),[1] which is a combination of basic pay, basic allowance for subsistence (BAS), and basic allowance for housing (BAH). Their basic pay is determined by their pay grades and years of service in the military., whereas BAH is determined by geographic duty location, pay grade, and dependency status. Furthermore, to help with the financial compensation, the government uses various bonuses called Special Pays. The Special Pays are discretionary bonuses given to Medical Corps officers intended to assist in alleviating shortages of medical officers in various U.S. Navy medical specialties and to help reduce the pay gap between military medical officers and their civilian counterparts (Office of the Chief of Naval Operations, 2005).

When an unobligated, fully-trained military physician leaves the military, his or her best alternative is to join the civilian sector. Military physicians, who earn significantly lower pay compared to their civilian counterparts, are more likely to be attracted to an opportunity to leave the Navy as soon as they complete their obligatory service. In order to reduce the pay gap between the military and the private sector, the

[1] Specific rates and entitlements can be found in the Department of Defense Financial Management Regulation (DODFMR), *Military Pay*, *Policy*, *and Procedures*, volume 7, part A, DOD 7000.

U.S. Navy has various types of Special Pay plans to minimize this gap. Therefore, the first phase of this thesis will examine the military-civilian healthcare pay gap. We will create a comparison of Navy and private sector physicians' total compensation across 19 specialties to determine whether a gap exists and, if so, the size of the gap.

In phase two, using a logistic regression model, we will investigate how the civilian-military pay gap for healthcare specialists impacts the probability that a fully trained healthcare specialist will stay in the Navy for an additional fiscal year after completing his or her initial ADO. The model's specifications will control for all observable factors that affect the retention of unobligated, fully trained specialists.

In phase three, we will use the model from phase two to estimate the retention elasticities for each specialty. This will provide information on the sensitivity of a physician's stay/leave decision based on the monetary incentive provided. The final phase will create an Excel-based projection model that predicts the retention rates of those in each specialty by adjusting the Special Pay level. This projection model would allow BUMED to set appropriate pay incentives in order to retain the desired healthcare specialists to meet its manpower requirements.

## A. PURPOSE

The purpose of this study is to reevaluate the effect of the civilian-military pay gap on the retention of unobligated Navy medical specialists. This thesis will replicate a previous study conducted by Shayne Brannman, Richard Miller, Theresa Kimble, and Eric Christensen at the Center for Naval Analyses (CNA) in 2002. In the last 10 years, with the prolonged GWOT and recent economic recession, the retention and attrition of Navy healthcare specialists has been challenged. This research will estimate the retention elasticity of each specialty using multivariate analysis and then incorporate the estimates into a projection model to accurately forecast future retention rates. This will help BUMED better assess its manning projections, as well as set adequate special and incentive pay rates to maintain the desired manning of skilled and experienced medical personnel. It will also help BUMED justify its pay rates with the Department of Defense (DoD).

## B. RESEARCH QUESTIONS

There are several primary questions that this research will attempt to answer:

- How does a change in the civilian-military healthcare specialist pay gap affect the retention of Navy medical specialists?
- What are the retention elasticity estimates for unobligated, fully trained Navy physicians with respect to civilian-military healthcare specialist pay gap changes?
- What are the projected retention rates for Navy medical specialists, and how would adjusting Special Pay incentives influence their retention?

Secondary questions that this research will attempt to answer are:

- How has the retention rate of Navy medical specialists changed from Fiscal Year (FY) 2002 through FY2011? Has it coincided with changes in the civilian-military ratio?
- Have the prolonged GWOT and recent economic downturn influenced the Navy's medical specialists' retention rate from FY2002 through FY2011?

## C. ORGANIZATION

This thesis is broken down into five chapters. Chapter II provides a comprehensive literature review of prior studies of military retention and the effect of Special Pays to retain Medical Corps providers. Chapter III will discuss the variables that were used to create the model, and will provide a summary of the descriptive statistics and retention projection model for Navy healthcare specialists. Chapter IV will provide the marginal effects and the elasticity estimates, and review how pay elasticity affects retention. Chapter V will provide a summary of the results, along with conclusions and recommendations.

# II. INSTITUTIONAL BACKGROUND AND LITERATURE REVIEW

## A. INTRODUCTION

Retaining skilled and qualified employees is one of the foremost challenges that all organizations share, including the military, for several reasons. First, organizations that face a high turnover rate incur high costs to attract qualified applicants to fill the vacancies and additional costs to train these new employees. Second, the cost of productivity loss and degraded readiness, as a result of high attrition, is inestimable (Weiss et al., 2003). Indeed, attrition in the military is more problematic; mainly, in occupations where a civilian-military pay gap exists and when the economy is thriving (Weiss et al., 2003). Military physicians who face a positive and growing gap between military and civilian compensations are more likely to pursue an increasingly attractive civilian employment, especially since their skills are easily transferable. In addition, because of the existing short supply of physicians in the civilian market and the high cost to recruit and train a new physician to become a specialist, the civilian sector competes to attract fully trained military physicians. This greatly affects military physicians' retention, contributes to an increased turnover of unobligated healthcare specialists, and puts stress on the military's personnel planning to retain these specialists.

This section provides a summary of the Medical Corps' institutional background and discusses prior studies of retention and pay gaps in the military healthcare profession. The first part provides information on the Medical Corps' accession source, bonus pay, and retention in the Medical Corps. The second part offers an overview of military retention models. It discusses empirical models and different methodologies used in previous studies of military retention. The third part summarizes previous empirical evidence of military retention. Since one of the primary objectives of this thesis is to estimate the retention elasticity for unobligated, fully trained Navy physicians with respect to changes in the civilian-military pay gap, this part mainly focuses on the reenlistment-pay elasticity estimates found in prior literature. This section includes a discussion of how and why these estimates varied over time. The fourth part of the

chapter offers a thorough review of prior studies of military physicians' retention. This thesis is a continuation of prior literature that has been conducted on military physicians' retention. It specifically examines the effect of the civilian-military pay differential on the retention of unobligated, fully trained Navy specialists and updates retention-pay elasticity estimates for 19 specialties. Therefore, methodologies used in previous studies, as well as past studies' findings, form the foundation of this research. The final part of this chapter is a review of prior literature on the effect of OPTEMPO on the retention of military healthcare professionals. Since one of the secondary questions of this thesis inquires about the effect of the protracted GWOT on Navy physicians' retention, it is worth reviewing prior studies in this domain.

## B. INSTITUTIONAL BACKGROUND

### 1. Accession Source

Even though this study's focus is not on the impact that accession sources have on retention, knowing the different accession sources is important to better understand how the pay gap may influence the stay/leave decision. The Navy is able to provide an incentive for future doctors to join by paying for their medical school. Once the cost of medical school is paid, however, the question becomes how long will doctors stay? How long a Medical Corps officer will stay or how long their ADO service will be is determined by the accession source. Once their ADO is completed, the first decision that the physician faces is whether to stay on as a Navy doctor, or to leave and continue their career in the civilian sector.

There are many ways to become a medical officer in the U.S. Navy. The three categories of accession are: medical students, medical residents, and practicing profession. These three sources are the primary methods used by Navy recruiters to fulfill the Medical Corps' manning requirements. Below are details of each accession source (U.S. Navy, 2013):

- **Medical Students:**
    - **Health Professions Scholarship Program (HPSP)**: This is a medical school program, where the students do not have to attend a military medical school.
        - A monthly stipend of $2,122 is provided to help cover living expenses for up to 48 months.
        - A sign-on bonus of up to $20,000.
        - Students receive 100% tuition coverage during medical school.
        - A four-year active duty obligation.
    - **Navy Health Services Collegiate Program (HSCP)**: Similar to the HPSP program, a student can receive from $157,000 to $269,000 while attending medical school. This includes:
        - A monthly military salary.
        - A generous housing allowance.*
        - A comprehensive health-care benefits package.
        - A four-year active duty obligation.

*Navy HSCP housing allowance is based on medical school location. Increased offer amounts are available in areas with a higher cost of living.

- **Uniformed Services University of the Health Science (USUHS):** The USUHS is the nation's federal health sciences university. Health professionals serve in the DoD and the United States Public Health Service.
    - Students' tuition is waived by the DoD.
    - Students receive the full salary of a junior officer.
    - Students receive the benefits of a junior officer.
    - A seven-year active-duty obligation.

- **Medical Residents:**
  - **Financial Assistance Program (FAP)**: Residents may receive supplemental income in medical residency through the Navy**,** which may offer $275,000 or more during students' medical residency. This includes:
    - An annual grant of $45,000 for up to four years.
    - A monthly stipend of $2,122 to help cover living expenses for up to 48 months.
- **Practicing Professionals:**
  - **Direct Accession (DA):** Practicing physicians can receive a sign-on bonus of between $220,000 and $400,000; this is based on the individual's specialty and service requirement.

### 2. Medical Corps Special Pay System

U.S. Navy medical providers have many types of pay and allowances that affect their total salary. Here are a list of the most common pay and allowances that affect a providers' total salary according to the Defense Finance and Accounting Service (DFAS) website:

- **Base Pay:** All military personnel receive this pay based on rank and time in service.
- **Allowances:** The most common allowances are BAS and BAH. All officers receive a set amount of BAS, which is solely based on being an officer or enlisted person. Conversely, all officers receive BAH, but it is determined by rank, location, and number of dependents (if any).

Besides receiving their normal base pay and allowances, Medical Corps officers are entitled to many types of Special Pays. These Special Pays are intended to keep Medical Corps officers' income comparable with their civilian counterparts and reduce the pay gap between military medical officers who meet specified criteria and their civilian specialist counterparts. The Special Pays awarded to the Medical Corps are: Incentive Special Pay (ISP), Additional Special Pay (ASP), Multiyear Specialty Pay

(MSP), Board Certified Pay (BCP), and Variable Special Pay (VSP). Some of these carry multiyear service agreements, and some only require annual commitments. These pays are in addition to Basic Pay, BAH, and BAS. Listed below is a brief description of each type of pay according to Navy's OPNAVINST 7220.17, in 2005:

- MSP: Annual payment amount for multiyear contracts, based on their specialty for which they are currently credentialed.
- ISP: Annual payment based on their specialty for which they are currently credentialed and practicing.
- VSP: Medical Officers on active duty who were ordered to active duty for a period of not less than one year at set amount.
- ASP: Annual payment to Medical Corps Officers, who agree to remain on active duty not less than one year, who has a current, valid, and unrestricted license.
- BCP: Annual Payment to Medical Corp Officers, who agree to remain on active duty not less than one year, who has a current, valid, unrestricted license and are board certified.

### 3. Retention

After the Medical Corps officer's initial obligation is over, there are many factors that affect their retention. Some of the key factors that influence whether an individual will stay are pay and benefits. Currently, Navy medicine offers a variety of pay incentives that help keep Medical Corps officers in the Navy, such as the previously mentioned MSP, ISP, VSP, ASP, and BCP. The Navy uses these Special Pays to reduce the pay gap between military and civilian providers and also as an award to Medical Corps officers in designated specialties to support desired staffing levels by specialty. Even though the Navy offers these various types of Special Pays to mitigate the pay gap, the Navy is continually challenged in meeting its manning requirements.

## C. LITERATURE REVIEW

### 1. Retention in the Military

#### *a. Overview of Retention Models*

A vast body of empirical research focuses on military retention in order to define, examine, and evaluate factors that influence the retention behavior of military personnel. Typically, military retention research has been conducted in one of three ways: large-scale surveys and qualitative studies, multivariate regression models, or specific conceptual models of retention behaviors that were proposed on the basis of theories and which have been evaluated (Weiss et al., 2003).[2]

The purpose of large-scale survey research is to examine and descriptively analyze a number of factors that are related to military personnel retention and investigate how these factors influence or predict the stay-leave decision of military personnel. For example, a preliminary analysis of a 1999 United States Marine Corps (USMC) retention survey was used to provide a descriptive analysis of factors affecting the retention behavior of USMC personnel (Kocher & Thomas, 2000). Results of this survey indicate that the most influential factors related to Marines' decisions to leave the service are military pay and civilian opportunities, while the factors most influencing Marines' decisions to stay are their pride in the Corps and its values (Weiss et al., 2003).

Another common method used to study military retention is utilizing multivariate retention models. To pinpoint the influential factors of military retention, researchers have constructed multivariate retention models based on Adams Smith's (1776) economic theory of occupational choice (Warner, 1978; Warner, 1979; Enns, Nelson, & Warner, 1984; Warner & Goldberg, 1984; Black, Hogan, & Sylwester, 1987; Gotz & McCall, 1980). The basic idea behind this theory is that rational individuals make their occupational choices based on a utility maximization concept. Military personnel maximize their utilities by making decisions either to stay in the military or leave and pursue civilian opportunities. This is often a function of pecuniary and nonpecuniary factors (Weiss et al., 2003).

[2] Bristol (2006) referred to Weiss et al. (2003) classification of military retention's empirical research in his study of the effect of operational tempo on the retention of Navy medical officers.

The final method of studying military retention takes a slightly different approach. In this method, retention is examined through the proposal and empirical evaluation of specific conceptual models of military retention behavior (Weiss et al., 2003). For instance, Kerr (1997) proposed that reenlistment is a function of civilian job opportunities, cognitive satisfaction with military life, military experience, and an individual's demographics and personal characteristics. In order to evaluate the model empirically, Kerr divided the sample into four groups, based on gender and term of enlistment, then analyzed each group separately. Kerr (1997) finds that, although many of the proposed factors were significant predictors of retention behavior, none of them were statistically significant across all four groups. Therefore, the reasons behind Marines' decisions to leave the military at their first and second decision points were somewhat different between males and females (Weiss et al., 2003).

### *b. Empirical Evidence of Military Retention*

Enlisted personnel retention studies mostly focus on first- and second-term reenlistment. Early studies (1975–1990) indicated that reenlistment elasticity, with respect to the military pay, fell between 1.0 and 2.5 with a few higher and lower estimates (Goldberg & Warner,1982; Warner & Goldberg, 1984; Hosek & Peterson, 1985; Daula & Moffitt, 1989; Cooke, Marcus, & Quester, 1992; Smith, Sylwester, & Villa, 1990; Shiells & McMahon, 1993; Warner & Solon, 1991), while recent studies showed a lower reenlistment pay elasticity (i.e., 0.5–1.5) (Mackin, Darling, Mackie, & Mairs, 1996; Mackin,1996).[3] On the other hand, officers' retention studies generally focus on retention at the end of the initial obligation of service date and the time of promotion to O-4. On the whole, officers' pay elasticity falls between 0.8 and 1.5 (Asch, Hosek, & Warner, 2007).

The variation in reenlistment-pay elasticity estimates obtained in prior literatures raises questions about whether the pay elasticity has changed over time or variations in the elasticity estimates can be attributed to other factors. Hansen and

[3]The enlisted pay elasticity estimates from various studies, including those mentioned here, and additional studies of officers' retention were brilliantly summarized by Warner and Asch (1995), Goldberg (2001), and Asch et al. (2007).

Wenger (2002) find that there has been very little variation in the pay elasticity over time and that the only significant variation happened at the beginning and end of the drawdown era. They affirm that most of the estimated variation found in prior literature results from different specifications in the empirical models used by researchers.

To come up with this conclusion, Hansen and Wenger (2002) construct a logit model to examine the relationship between relative compensation and first-term reenlistment of Navy enlisted personnel, using data on male sailors who were eligible for reenlistment during the period FY1987-FY1999. Their baseline model estimates a pay elasticity of 1.5 and a one-level increase in the selective reenlistment bonus (SRB) multiplier generates a 2.5 percentage point increase in reenlistment. On the other hand, when they use different model specifications on the same dataset, the pay elasticity estimates ranged from 0.4 to 2.9 and a similar variation in the effect of the SRB on retention was observed. The difference in elasticity estimates did not reflect a change in sailors' reenlistment behavior, but rather a difference in model specifications that attributes to the elasticity variation. Hansen and Wenger (2002) find that there is very little variation in pay elasticity from FY1987 through FY1999, and the only significant variation happened at the beginning and the end of the drawdown. The variation in elasticities due to different model specification, however, is much higher than the variation observed over time (Hansen &Wenger, 2002).

### 2. Military Physicians' Retention

It is costly to recruit and train healthcare specialists. In addition, due to the limited supply of physicians, the civilian sector competes to attract the skilled and experienced military physicians by offering higher compensation and better job stability, especially since their skills are easily transferable. This contributes to high rates of attrition among unobligated, fully trained specialists and puts a stress on military personnel planning to retain them.

Since financial factors, such as compensation and bonuses, have a significant influence on physicians' decisions to stay or leave the military, the vast body of empirical research has focused on the effect of the civilian-military pay gap on uniformed physicians' retention. Yet, some other studies have examined how physicians' retention

behavior is influenced by nonpecuniary factors such as work conditions, job satisfaction, family adaptation, and operational tempo.

The study that most closely follows our research was conducted by McMahon, May, Graham, & Dolfini (1989). They analyze the role of the civilian-military pay differential and its influence on Navy physicians' retention. Their study focuses on the first decision point of fully trained, unobligated physicians in 22 specialties, who were on active duty from FY1983 to FY1987. Data on physicians' military compensation, along with their background and personal characteristics, were gathered from the Bureau of Medicine Information System (BUMIS), while alternative civilian pay information was provided by the Association of American Medical Colleges (AAMC). Their premier descriptive data analysis indicated a positive and growing civilian-military pay gap, with an average of $25,000, and ranged from $1,200 for pediatricians to $117,200 for thoracic and cardiovascular surgeons. In addition, the retention of fully trained, unobligated specialists decreased from 47% in FY1984 to 34% in FY1987. The authors utilized a logistic regression model to estimate the effect of civilian-military pay differential on the probability that a specialist would leave the Navy, and then constructed elasticities of attrition probability, with respect to changes in the pay differential, for 22 specialties. Other factors were controlled in order to obtain an unbiased estimate of the effect of the pay gap on attrition. These factors include types of accession and personal characteristics such as minority status, number of dependents, Year of Service (YOS) toward retirement, and taste of military life. The logit model's results indicated an aggregate elasticity of 0.15 and a high elasticity of attrition, with respect to the pay deferential for thoracic and cardiovascular surgeons and for neurosurgeons (0.71 and 0.72, respectively), and a low elasticity of attrition for pediatricians and family practitioners. These results explain why specialists with large pay differentials show the greatest retention responsiveness for specific reduction in the pay gap.

Accordingly, McMahon et al. (1989) proposed three alternative pay plans for the Navy to retain its experienced and skilled healthcare professionals. Table 1 summarizes the outcome of each alternative plan as well as an evaluation of each one. The authors

implicitly recommend Plan III, which pays all fully trained, unobligated physicians 90% of their alternative civilian median outcome. The reasons that promote this option, besides its competitive cost, are that it is simple and can be easily adjusted as civilian alternative pay changes. Also, Plan III may prevent future distortion in the civilian-military pay gap and consequent retention problems (McMahon et al., 1989).

Table 1. Evaluation of Alternative Pay Plans.

| Plan | Raise | Coverage | Cost ($M) | Retention (%) | Evaluation |
|---|---|---|---|---|---|
| I | Pay 48% cost-of-living adjustment to all specialty pays. | All physicians | 15.2 | 23 | Does not address targeted specialties, which still suffer a high civilian-military pay gap. Some specialties would be paid more than the civilian median. |
| II | Pay alternative civilian median if FY1988 inventory is less than 90% of the FY1990 authorized end strength. | All fully trained, unobligated physicians | 13.8 | 38 | Does not address specialties with high gap and low retention. Bonuses vary with time. So, long-term discounting cannot be done due to uncertainty. Does not account for cost-of-living adjustment. |
| III | Pay 90% of the alternative civilian median income. | All fully trained, unobligated physicians | 13.7 | 38 | Does not waste money by overcompensating. Perceived as fair by all physicians. Pay may increase for specialties that have no retention problem. Creates a variation in pay across specialties. |

It is worth mentioning that McMahon et al. (1989) find that the elasticity estimates could underestimate the retention behavior, since there is a small variation in military pay within specialties and it would have been better if data were collected over a longer period of time. In addition, the model specifications used in the study could suffer from omitted variables biasness, since physicians' dissatisfaction with regard to work conditions and military supervision is not included. The authors indicate, however, that this effect across all physicians should not lead to any bias in the predictive value or the interpretation of the model.

Lane and Melody (1998) study the change in Navy specialists' retention as a result of healthcare reform and the accelerated movement toward managed care in 1992. The managed care environment had shifted the demand away from certain specialties and

toward primary care practicing, which resulted in an increase in civilian earnings for primary care physicians and a decrease in earnings for some other specialties. To examine the sensitivity of Navy specialists to changes in the relative size of the pay differential, Lane and Melody (1998) constructed a logistic regression model based on pooled, cross-sectional data of Navy specialists who were reaching their initial decision point or subsequent decision points from FY1992 through FY1996. This data were obtained from the Health Manpower Personnel Data System (HMPDS), which was provided by Defense Manpower Data Center (DMDC), while their civilian counterparts' compensation data were obtained from the AAMC and Hay group surveys. Using a logit model, they estimate the probability that an unobligated, fully trained physician will stay in the Navy as a function of civilian-military pay differential (primary factor), personal demographics, rank, YOS, accession sources, and a taste for Navy life.

Lane and Melody's (1998) preliminary descriptive analysis shows an overall positive and growing difference between civilian and military pay. This difference increases with years of experience for all specialties and was higher for specialists who required an extensive training. As of 1996, the average military/civilian pay ratio for all specialties was reduced to 0.66, compared to the 0.79 obtained by McMahon et al. (1989) earlier, in 1988. Lane and Melody (1998) estimate an aggregate retention-pay elasticity of 0.23 using AAMC data, compared to 0.15 estimated by McMahon et al. (1989) in 1988. Primary care physicians show a higher sensitivity to pay in recent years, indicating that managed care had shifted the retention responsiveness of primary physicians, which dropped from 80% in the 1980s to 65% in the late 1990s. The overall estimates from the logit model, using Hay group data, show less sensitivity than the one using AAMC data. One explanation for the difference is that Hay group data display a higher variation in pay differentials among specialists.

Previous studies examining the rate of retention for Navy physicians show that the rate of retention is declining for some specialties. These studies, however, only focus on the "total pool of un-obligated physician specialties" (Christensen, Brannman, Almendarez, Sanders, & Kimble, 2002, p. 1). This overemphasizes physicians who might not be committed to staying in the Navy. As a result, a historical overview and retention

analysis on Navy specialty physicians from FY1987 to FY2000 was conducted by Christensen et al. (2002) to identify and track critical indicators that predict the trends of the Navy Medical Corps' work force, as a whole, as well as for each individual specialty. They compare these trends to the civilian sector to assess if notable changes were unique for the Navy. In particular, this will provide insight into whether the Navy cannot fill its specialty physicians' billets or if there is an insufficient physician in the pipeline.

Given these critical indicators, the historical overview of all Navy physicians indicates a reduction of 7% in the total inventory from FY1987 through FY2000. Despite this downtrend, the number of fully trained specialists and executive medical officers increased by 29%, which implies an increase in the Navy's ability to fill its billets during that period. This suggests that the downtrend came from a reduction in the number of physicians in the pipeline, which signals a shortage of physicians to fill these billets in the future. When Christensen et al. (2002) analyze the distribution of specialties by category, they find that as of FY2000, 43% of all physicians were in primary care specialties, while surgical and other specialties accounted for 26% and 31%, respectively. Comparing this distribution mix with the civilian sector shows a similar pattern. These changes in specialty mix, with a higher percentage of primary care specialties and lower percentage of surgeons in both the Navy and the civilian sector, indicate a national movement towards managed care. This conclusion supports the finding of Lane and Melody (1998).

Besides observing force structure critical indexes to measure the historical behavior of Navy physicians' inventories, Christensen et al. (2002) evaluate the retention of the Navy Medical Corps based on the matriculation rate of new accessions into the specialty pool and the attrition rate of fully trained specialists out of the pool. To examine the matriculation rate, Christensen et al. (2002) evaluate the three predominant accession sources: Armed Forces Health Professions Scholarship Program (AFHPSP) direct accessions, AFHPSP fully deferment accessions, and USUHS accessions. They find that the percentage of AFHPSP direct accessions who became residents before 1988 is 14% higher than those who joined the residency program afterward. Furthermore, after 1988, the accumulative retention rate of AFHPSP direct accessions who became fully trained specialists two years after ADO completion is 7% higher than the retention rate before

1988. These changes in retention patterns are referred to a policy change in the obligation service associated with residency training.[4] The evaluation of the matriculation rate for USUHS did not reflect such effects of the obligated policy change because USUHS accessions have seven years of initial obligation service compared to four years for AFHPSP direct accessions. Similarly, the policy change has no effect on fully deferred AFHPSP accessions, since they joined the service as fully trained specialists. A 1988 policy change, however, may increase their obligation service by one year, if they decide to join a fellowship program after 1988.

With regard to the attrition rate of fully trained specialists out of the specialty pool, Christensen et al. (2002) examine three specialty groups: primary care, surgical specialties, and other specialties. They find that primary care specialists' attrition rate was not statistically different before or after the obligation service change in 1988 and their average attrition rate at one, two, three, and four years after completing the ADO are 50%, 55%, 60%, and 63%, respectively. For surgeons, the overall attrition has declined from 59% before the policy change to 44% after 1988. Similarly, other specialties' cumulative attrition rate had been reduced from 54% to 38% after 1988.

Brannman et al. (2002) analyze the retention behavior for Army, Navy, and Air Force (AF) military physicians from FY1991 to FY1998, as a part of their report to Congress regarding health professionals' retention-accession incentives. They examine attrition and continuation rates[5] for 23 specialties and construct a duration model to study the survival of military physicians within these specialties. They use DMDC data that contains information on demographics and personal information of all military physicians from FY1991 to FY1998, as well as information on their military compensation. Hay group's data are used as well to obtain information on civilian-sector compensation for each specialty during the same period.

[4] Before April 1988, in-house residents were obligated neutral with a minimum of two YOS required upon the completion of the residency program, while after April 1988 in-house residents were obligated to serve years-for-year of residency training, which is served concurrently with any existing obligation.

[5] The continuation rate was examined by a percentage of physicians who were on active duty as of the beginning of a given FY and were in uniform in subsequent years.

Brannman et al. (2002) find that an aggregate attrition rate for fully trained, unobligated specialists had increased slightly over time. This change, however, was not statistically significant. Similarly, the aggregate continuation rate did not change significantly over time. It was surprising that the attrition/continuation rates had not changed significantly during the 1990s, given the existing wide gap between military and civilian compensation for all of the 23 specialties. Brannman et al. (2002) indicate that the civilian-military pay gap could have had a little effect on attrition or it might have had increased the attrition, but this increase was offset by other factors. Another explanation is that the attrition varied across specialties. If specialties with lower attrition make up a great portion of the total inventory, they will make the overall increase in attrition across all specialties. Moreover, changes in civilian pay and healthcare system practices could affect military physicians' attrition negatively, despite the wide gap in civilian-military pay.

With respect to the duration model of military physicians during the 1990s, Brannman et al. (2002) examine the influence of the civilian-military pay gap on the probability of a physician to attrite at any given point in time (t), given that he/she has been unobligated for a defined period of time leading up to (t). This is commonly known in the literature as the Hazard Ratio of attrition. Brannman et al. (2002) estimate an aggregate duration model and separate models for three specialty groups: primary care specialties, surgical specialties, and other specialties.

The results of the duration model, with respect to the civilian-military pay gap effect on retention of military specialists, indicate that, on average, military physicians are modestly sensitive to pay differential changes and the average career length elasticity is 0.25. Detailed effects by specialty show that the pay differential has no significant effect on the career length of primary care specialists. This indicates that primary care physicians decide to stay or leave based on factors other than financial aspects. Furthermore, the pay gap has a significant, but weak, negative effect on surgeons' career length, with elasticity of 0.32. Similarly, there is a negative and significant effect of civilian-military pay differential on the career length for anesthesiologists, radiologists, pathologists, and psychiatrists, with elasticity ranges from 0.3 to 0.65. Moreover, a strong

and negative relationship is found between the pay differential and the career length of internal medicine specialists, with an elasticity of 1.25. In addition, gender has no effect on specialists' career length, while physicians who are closer to retirement exhibit a longer career length for most specialties.

### 3. The Effect of Operational Tempo on Military Healthcare Professionals' Retention

The main focus of this study is to investigate the effect of the civilian-military pay gap on Navy Medical Corps retention; however, we also explore the influence of OPTEMPO on the retention of Navy physicians to answer one of the secondary questions of this thesis, which seeks to estimate the effect of the protracted GWOT on Navy's physicians' retention, given the long span of the GWOT over the last decade. Therefore, despite the fact that they are extremely limited, it is worth recalling prior research on the effect of OPTEMPO on the retention of military caregivers.

Pierre (2005) examines the impact of increased OPTEMPO, influenced by the tragedy of 9/11, on Navy hospital corpsmen's retention. She applies logistic regression models on two datasets: one for all Navy hospital corpsmen who were on active duty on September 1, 1998 and became eligible for reenlistment before September 11, 2001, and the other consists of all hospital corpsmen that were on active duty after September 11, 2001 and became eligible to reenlist before March 31, 2004. She then compares the results to investigate the effect of increased OPTEMPO, imposed by the GWOT after 9/11, on the retention of hospital corpsmen. Her findings indicate that deployment has a positive effect on the retention of Navy hospital corpsmen. In addition, she finds that the retention rate increases by 20% for those who joined the Navy after September 11, 2001, relative to the retention rate of the 1998 group.

Bristol (2006) studies the influence of increased OPTEMPO on Navy Medical Corps retention. He obtains data for two distinct cohorts: a cohort of all active duty physicians who were serving in the Navy on October 1, 1999, and all active duty physicians serving in the Navy on October 1, 2002. Bristol (2006) implements a difference-in-difference estimator in his logistic regression models to compare the change

in retention behavior of nondeployers who were not affected by the increase in OPTEMPO, with the change in retention behavior of deployers who were affected by the increased OPTEMPO. Bristol (2006) finds that increased OPTEMPO has a negative effect on GMO retention. A GMO who was deployed after the OPTEMPO had increased (2002 cohort) has a retention probability of 9.59 percentage points lower than nondeployers before the increased OPTEMPO. Similarly, a specialist who was deployed after the increased OPTEMPO has a retention probability of 14.81 percentage points lower than a nondeployer specialist in the 1999 cohort.

Dietrich (2007) examines the effect of the GWOT/OPTEMPO on the retention behavior of the Navy Medical Service Corps (MSC) who were on active duty from 1997 through 2005. He employed logistic regression models that incorporate difference-in-difference estimators to measure the effect of increased OPTEMPO imposed by GWOT on the first-term retention of unobligated Navy MSC. Dietrich (2007) finds that MSCs who served in 2001 had a lower probability to stay in the Navy by approximately 9% than those who served in 1998 and 1999. Furthermore, his results show that, in general, deployment has a positive and statistically significant effect on MSC members' probability of staying for a second-term obligation. An MSC officer who was deployed has an increased probability to stay by 5.1%. If he/she had at least one hostile deployment, his/her retention probability increases by 7.7%. On the other hand, difference-in-difference estimators indicate that there was no statistical difference between the effect of deployment in the post-GWOT period and its effect in the pre-GWOT period on MSC members' retention. Therefore, Dietrich (2007) suggests that there are other important factors that have not been controlled for such as fear of deployment, deployment uncertainty, increased stress and workload imposed on nondeployers as a result of deployments, or better civilian opportunities for MSC members who served in 2001, could have caused the decreased retention rate of the MSC.

The findings of previous studies confirmed that military medical care professionals showed a higher rate of retention in the early stage of the GWOT (Pierre, 2005; Dietrich, 2007). This increase in retention is attributed to an increase in patriotism,

which led to a commitment for staying on active duty to protect the nation (Pierre, 2005). The increased OPTEMPO, however, had a negative effect on retention, especially after FY2002 (Bristol, 2006).

A lot has changed during the past decade. The nation fought two wars that lasted until the end of 2011. The economy was booming during the first half of the decade, but since the real estate and stock market bubble burst in 2008, the economy has shrunk and the United States is still quarrying out from the debris of the collapse of the financial system. All of these factors certainly have an impact on the health care market, especially the supply and demand of fully trained physicians. Unobligated military specialists opt to stay in the service or leave and join the civilian sector. They make their decisions based on many influences, but, most importantly, based on financial factors. This study sheds a light on the retention of fully trained, unobligated Navy Medical Corps personnel during the last decade. This thesis is a continuation of prior research that examines the effect of the civilian-military pay gap on the retention of the Navy's physicians. It also updates the retention elasticity for the overall Medical Corps and 19 medical specialties. Furthermore, this study estimates the projected retention rates for Navy Medical Corps. In addition, it evaluates how the protracted GWOT affected the retention behavior of Navy medical specialists during the past decade.

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# III. DATA SOURCES AND PRELIMINARY DATA ANALYSIS

## A. DATA SOURCES

### 1. Bureau of Medicine and Surgery (BUMED)

The BUMIS is considered the most reliable data source for Navy medicine. BUMIS data contains records of all individuals in the U.S. Navy Medical Corps. We obtained this data from BUMED, for FY2001 through FY2011, in order to perform our study. The BUMIS dataset includes observations of all Navy physicians from FY2001 through FY2011. The BUMIS data provides general demographic information, source of commission, obligated service date, medical subspecialty, rank, and Special Pays (except VSP). The BUMIS data do not contain any information on marital status or dependents and/or information regarding the amount of RMC each provider received. It does, however, contain the data to compute what the providers' RMC would be.

The data set for our sample contains a total of 48,000 observations for the sample years between FY2001 and FY2011. The sample size was reduced from its original size to 4960 observations in order to create a more manageable work file. We eliminate the variables for General Medical Officer (GMO) and attrite before completion of obligation service. Furthermore, we do not have information on those who stayed in the Navy in FY2000 and who left in FY2001, we only observe the physicians who became unobligated and stayed in the Navy during FY2001. Due to this constraint, all observations of FY2001 were deleted and the analyses are conducted for the years FY2002 through FY2011.

While the BUMIS data does contain information on providers who received ISP and MSP each FY, the data does not reflect the true decision point to stay in or leave the Navy. This is because if some physicians left mid FY then the data would not reflect that individual receiving ISP and MSP. Therefore, we manually created a database from BUMED's website, which shows how much each provider receives for every FY. The BUMIS data does not include a YOS variable; however, we construct one in our file by using the Active Duty Base Date (ADBD) variable that the BUMIS data provides.

### 2. Regular Military Compensation/Special Pay

In order to compensate for these deficiencies, we have manually created a database from the DFAS website that shows what the base pay and BAS would be from FY2002 through FY2011. We created a database for pay grades O-3 through O-5, from 0 years of service to 40 years. Pay grades for O-1, O-2, and O-7 and above were not included because at pay grades O-1 and O-2 the physicians are still in obligation status, and pay grades O-7 and above are in executive medicine positions and, therefore, not doing any clinical work since they are in executive leadership positions.

The BAH is based on Unit Identification Code (UIC), rank, and with/without dependents status. To create a BAH table for FY2002 through FY2011, we used the historical FY2002 through FY2011 data from the Defense Travel website (Defense Travel Management Office, 2013). The BAH was estimated using service-wide UIC averages based on rank and the assumption that the provider is in "with dependent" status.

Medical Corps officers are entitled to many Special Pays. The ISP and the MSP are Special Pays specifically designed to allow the U.S. Navy to assist in alleviating specific shortages and retain medical officers in specific specialties. Appendix A gives a breakdown of what the ISP and MSP are for each specialty by FY.

### 3. Civilian Pay File

The civilian physician compensation data for FY2001 through FY2011 was obtained from Medical Group Management Association (MGMA) Physician Compensation and Production Surveys. For FY2001 through FY2011, MGMA surveyed medical practices to obtain recent physician compensation data. They sent out 31,549 surveys to obtain physician compensation for the various physician specialties and aggregated the responses to create an average pay for each specialty in the civilian sector. The civilian compensation total represents the physician's gross income, before taxes.

## B. OBLIGATION

The U.S. Navy has many accession programs to encourage an individual to

become a U.S. Navy medical provider. The accession source and training pipelines that the individual selects will determine their length of obligation. Using only the BUMIS data to determine someone's end of obligation is very difficult. Based on the data, we were unable to precisely determine someone's end of service obligation. This was due to inconsistent BUMIS data and/or it was unclear whether the provider is serving his/her initial obligation or serving another obligation that the provider incurred through some other source. We were able to resolve some of these issues by looking at the individual's obligated service date (OSD) variable and creating a longitudinal database.[6] With this database, we are able to look at retention of physicians under both their initial and their subsequent obligation.

## C. PRELIMINARY DATA ANALYSIS

Our study will examine how changes in the civilian-military pay gap affects the decision of unobligated Navy physicians to stay in or leave the Navy at their next decision point across all specialties for the years between FY2002 and FY2011. We will not only look at the initial decision point, but we will also examine the behavior of Navy physicians for subsequent annual decision points. This section will summarize the data used for the model and provide a preliminary data analysis prior to presenting the empirical methodology.

After combining the three data files, and eliminating all missing values, the final sample consists of 4,960 observations. Table 2 presents the number of providers that were unobligated and eligible to make retention decisions for FY2002 through FY2011. This table shows that the overall number of personnel who decided to stay at each respective decision point decreased from FY2002 through FY2011, trending downward by 57%.

[6] Lane and Melody (1998) encountered similar challenges with BUMIS data. Accordingly, they conducted their analyses for the initial and subsequent decision points.

Table 2. Number of Unobligated Providers at a Decision Point to Leave the Navy by FY.

| | Fiscal Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **Total** |
| **N=** | 634 | 642 | 726 | 633 | 534 | 475 | 377 | 331 | 324 | 284 | 4,960 |
| **Stayers=** | 453 | 484 | 563 | 449 | 329 | 303 | 207 | 200 | 174 | 164 | 3,326 |

Table 3 provides summary statistics for the demographic variables as well as the average retention rate and civilian-military pay gap for the entire sample period. The overall retention rate for the unobligated providers at a decision point to leave the Navy is 67%, with the civilian-military pay gap at an average of $98,787.41. The majority of personnel making these decisions is, on average, 39-years old, male, white, Lieutenant Commander (LCDR), and has been in the Navy for approximately 10.9 years.

Table 3. General Data Description.

| Variable Name | Mean | Standard Deviation |
|---|---|---|
| Stay | 0.68 | 0.47 |
| CivMilGap | 98787.41 | 86485.12 |
| Female | 0.28 | 0.45 |
| Black | 0.09 | 0.28 |
| Asian | 0.05 | 0.21 |
| Hispanic | 0.02 | 0.15 |
| Other | 0.04 | 0.20 |
| LT | 0.08 | 0.27 |
| LCDR | 0.68 | 0.47 |
| CAPT | 0.01 | 0.30 |
| USUHS | 0.14 | 0.35 |
| AFHPS_DEF | 0.26 | 0.42 |
| FAP | 0.01 | 0.10 |
| YOS | 10.90 | 6.40 |
| AGE | 39.27 | 6.30 |

Figure 1 illustrates changes in the Medical Corps retention rate in relationship to the civilian-military pay gap over time. The figure indicates that the Medical Corps retention rate has been on a downward trend, whereas the civilian-military pay gap has steadily increased. This provides anecdotal evidence that reduced retention of Navy physicians over time is partly explained by increased salary in the civilian sector.

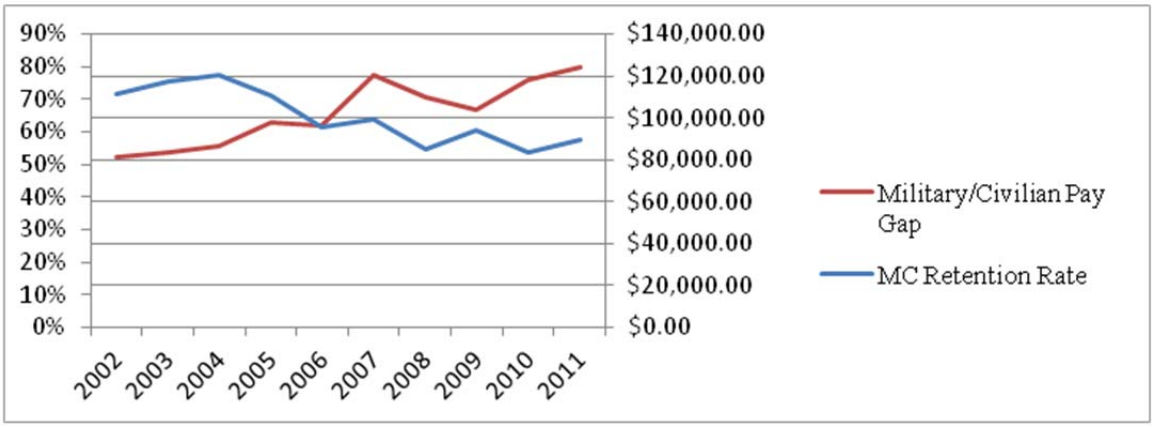


Figure 1. Medical Corps (MC) Retention Rate vs. Civilian-Military Pay Gap.

Overall, the civilian-military pay gap, on average, has increased 34% in the last nine years, growing from $81,807.40 to $123,950.60. One explanation for the increase in the pay gap is the rising health care costs in the United States. The rising health care costs can be attributed to a large extent, to the shrinking workforce, emerging technology, and changing reimbursement structures (Lanser, 2003). This may suggest that due to the insufficient supply of physicians, the civilian providers were able to receive an increase in pay.

### 1. Data Description

Table 4 provides a detailed[7] description of the provider demographics for the first and last year of our sample. Frequency distributions and descriptive statistics are presented to illustrate changes in the characteristics of the sample over time in an effort to better understand the factors that influence a physician decision to stay or leave the Navy.

[7] Subspecialties and FY were included in our model; however, for purposes of space, we did not include those variables in our table.

Table 4. Data Description of the Demographics Variables used in the Model.

| Characteristics | FY2002 (N= 610) | | FY2011 (N= 261) | | % Change Between FY2002 and FY2011 |
|---|---|---|---|---|---|
| | Mean | STD. DEV | Mean | STD. DEV | |
| **Gender (%)** | | | | | |
| Male | 73.50 | | 72.80 | | –0.70 |
| Female | 26.55 | 44.20 | 27.20 | 44.59 | 0.65 |
| **Race (%)** | | | | | |
| White | 77.70 | 41.66 | 78.92 | 40.87 | 1.22 |
| Black | 2.62 | 15.99 | 5.75 | 23.32 | 3.13 |
| Asian | 3.44 | 18.25 | 9.96 | 30.00 | 6.52 |
| Other | 14.26 | 34.99 | 2.68 | 16.19 | –11.58 |
| Hispanic | 1.97 | 13.90 | 2.68 | 16.19 | 0.71 |
| **Rank (%)** | | | | | |
| CAPT | 5.57 | 22.96 | 10.34 | 30.51 | 4.77 |
| CDR | 9.50 | 29.36 | 20.69 | 40.59 | 11.19 |
| LCDR | 70.33 | 45.72 | 67.05 | 47.09 | –3.28 |
| LT | 14.59 | 35.33 | 1.92 | 13.73 | –12.67 |
| **Accession Source (%)** | | | | | |
| AFHPS_DEF | 23.93 | 42.70 | 23.75 | 42.64 | –0.18 |
| AFHPS | 66.23 | 47.33 | 62.07 | 48.61 | –4.16 |
| USUHS | 9.83 | 29.80 | 11.11 | 31.49 | 1.28 |
| FAP | 0 | 0 | 3.07 | 17.27 | 3.07 |
| **Years of Service & Age** | | | | | |
| YOS | 9.23 | 5.50 | 12.32 | 6.74 | 3.09 |
| AGE | 37.50 | 5.43 | 41.03 | 6.54 | 3.53 |

Table 4 suggests that there is negligible change in the gender composition over time for Medical Corps officers in the Navy, though ethnic diversification has increased in the White, Black, Asian, and Hispanic categories. The table further suggests that the number of senior officers making decisions to stay in or leave the Navy has increased by: Captain (CAPT)/4.77% and Commander (CDR)/11.19%; however, the number of junior officers doing so has decreased: LCDR/–3.28% and Lieutenant (LT)/–12.67%. This may explain why the average age (+3.53) and YOS (+3.09) have also increased over the sample period. With respect to the accession source, the number of Medical Corps officers retained increases the most with USUHS relative to the other accession sources.

Figure 2 shows changes in the Navy Medical Corps' retention rates from FY2002 to FY2011 in relation to the Medical Corps ISP and MSP. This graph shows that the

Medical Corps' retention rate has steadily decreased since 2004, and it appears that a drop in retention rate does not translate to an increase in Special Pays during the following year.

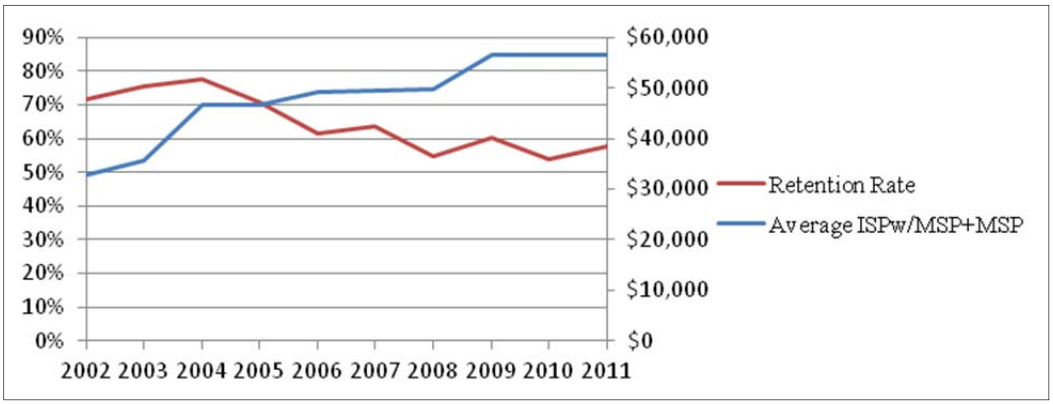


Figure 2. Medical Corps' (MC) Retention Rate vs. ISP/MSP Bonus Pay.

Figure 2 illustrates that the concern about reverse causality, whereby a drop in retention rate in *t-1* year causes an increase in special bonus in year *t*, is likely minimal in our study. The Navy sets bonus pay based on end-strength quotas; however, Navy officers make a decision to stay based partly on the amount of the bonus pay. Using methods consistent with a prior study (Brannman et al., 2002), we do not believe this endogeniety issue will bias our elasticity estimates. In our study, however, we do see that retention is trending downward between FY2007 and FY2008, followed by an increase in bonus between FY2008[8] and FY2009, which would be consistent with the reverse causality effect. Likewise, a drop in retention between FY2004 and FY2005 is followed by increase in bonuses between FY2005-FY2006. This is counterintuitive, since previous studies have shown an increase in the U.S. Navy's retention rate during this time frame. This suggests that the Medical Corps' retention rates and Navy-wide retention rates are differentially affected across the nine years of our study.

[8] According to the Bureau of Labor Statistics, the U.S. economy started its recession in December 2007.

The highest retention rate was in FY2004, which was a year after the GWOT started. This can be explained by a high acceptance rate of U.S. involvement in the GWOT among U.S. citizens.

### 2. Civilian-Military Pay Gap Among Specialists

Between the years FY2002 and FY2011, there were 4,960 providers who were able make a decision to stay in or leave Navy. Table 5 shows the aggregate number of officers in each specialty that were at a decision point for the years between FY2002 and FY2011. The Primary Care Service Provider compromises the largest number of officers (37.35%) who potentially might leave. They were followed by other specialties at 36.2% and then surgical at 26.4%.

Table 5. Decisions Makers in Specific Specialties.

| Specialty | Frequency | Percent |
|---|---|---|
| Anesthesiology | 368 | 8.22 |
| General Surgery | 219 | 4.89 |
| Neurological Surgery | 27 | 0.60 |
| OB/GYN | 349 | 7.79 |
| Ophthalmology | 96 | 2.14 |
| Orthopedic Surgery | 279 | 6.23 |
| Otolaryngology | 119 | 2.66 |
| Urology | 94 | 2.10 |
| Occupational Medicine | 94 | 2.10 |
| Physical Rehabilitation | 19 | 0.42 |
| Pathology | 119 | 2.66 |
| Dermatology | 147 | 3.28 |
| Emergency Medicine | 425 | 9.49 |
| Family Practice | 921 | 20.57 |
| Internal Medicine | 296 | 6.61 |
| Neurology | 43 | 0.96 |
| Pediatrics | 362 | 8.08 |
| Psychiatry | 215 | 4.80 |
| Radiology | 286 | 6.39 |
| Total | 4,478 | 100% |

Table 6 presents the pay gap between civilian and military specialists, broken down by years of experience in their respective specialty. We have broken the categories down by the following years of experience: 2 years, 7 years, 17 years, and 18+ years. These benchmarks were selected because these are the years that were used in the civilian data.

Table 6. Average Civilian-Military Pay Gap by Years of Experience.

| | 2 Years | 7 Years | 17 Years | 18+ Years |
|---|---|---|---|---|
| Anesthesiology | $153.067 | $213.181 | $217,895 | $167,073 |
| General Surgery | $121,726 | $169,860 | $166,912 | $131,982 |
| Neurological Surgery | $374,473 | $442,960 | $508,304 | $404,430 |
| OBGYN | $77,217 | $111,753 | $111,314 | $141,999 |
| Ophthalmology | $202.055 | $136,429 | $155,661 | $130,711 |
| Orthopedics Surgery | $80,617 | $291,931 | $303,349 | $203,544 |
| Otolaryngology | $131,392 | $183,884 | $175,240 | $132,758 |
| Urology | $121,666 | $187,835 | $210,003 | $144,656 |
| Occupational Medicine | $48,559 | $48,559 | $59,424 | $26,898 |
| Physical Rehab | $47,978 | $87,440 | $87,857 | $48,837 |
| Pathology | $52,455 | $140,220 | $181,582 | $199,713 |
| Dermatology | $127,594 | $198,799 | $194,247 | $177,446 |
| Emergency Medicine | $95,475 | $102,127 | $96,553 | $75,495 |
| Family Practice | $30,217 | $46,902 | $42,633 | $14,089 |
| Internal Medicine | $35,463 | $51,874 | $50,746 | $18,440 |
| Neurology | $52,185 | $91,728 | $74,311 | $56,371 |
| Pediatrics | $20,098 | $42,200 | $48,135 | $16,890 |
| Psychiatry | $53,850 | $66,382 | $40,370 | $11,027 |
| Radiology | $170,909 | $287,913 | $326,075 | $274,173 |

Table 6 shows that military physicians across all specialties are underpaid compared to their civilian counterparts (i.e., all pay gaps are positive in the table) and that the Primary Care Service has the smallest military pay gap, compared to the other services. The Primary Care Service pay gap[9] was approximately $37,570 dollars, whereas Surgical Specialties had a gap of $196,198 and other services had a gap of $130,908, on average. This table may suggest that Primary Care will have the highest retention rate

[9] For a detailed breakdown, see Appendix A. We also did not take into account any tax benefits that BAH and BAS offers in this table.

because it has the lowest civilian-military pay gap. In addition, we can see that all the specialty pay gaps reach their peak at 17 years, and then the gap decreases thereafter. This can be explained by the fact that, in the military pay system's structure, the providers pay increases every year until retirement. In the civilian sector, however, salaries generally plateau when certain years of work experience and milestones are reached.

In summary, these tables and figures provide information that the civilian and military pay gap, across specialties, can have an effect on the retention rate of Medical Corps officers. There are other factors that can have an effect on retention such as working conditions, military lifestyle, and OPTEMPO. In Chapter IV, we will estimate how the pay gap will affect each specialty's elasticity with regard to staying in the Navy, controlling for working conditions, military lifestyle, and OPTEMPO.

# IV. GENERAL METHODOLOGY

## A. RETENTION ANALYSIS

Multivariate regression analysis is used to estimate the retention probability of fully trained, unobligated Navy physicians. These models are incorporated with all possible influence variables in order to obtain unbiased estimates. Since the dependent variable (STAY) is a dichotomous, binary variable with value of (1) if a physician stays and (0) if he/she leaves, probit regression models are more appropriate to be used than Ordinary Least Squares (OLS) models. The greatest disadvantages of OLS models are, first, the fitted probability of stay or leave decisions can be less than zero or more than one, which makes no sense. Second, the partial effects of the explanatory variables are constant using OLS specification. Therefore, utilizing a probit binary response model is adequate to specify predictions that fall within 0–1 values.

The sign of an explanatory variable's parameter shows whether the variable is associated with an increased or decreased retention probability. The partial effect of any given explanatory variable indicates the magnitude of the change in the retention probability as a result of a change in that given explanatory variable and is evaluated using the representative person approach. The representative person approach defines a typical physician with a set of traditional characteristics to whom the partial effect is calculated. In this thesis, that reference physician is a White, male physician who accessed the Navy through the AFHPSP and holds the rank of commander.

### 1. Multivariate Regression Models' Specification

#### *a. Main Retention Model*

A multivariate probit regression model is constructed to estimate the aggregate retention probability for fully trained physicians who became unobligated from FY2002 through FY2011. The retention behavior is evaluated at initial and subsequent decision points. The main empirical probit model is shown in Equation (1):

$$Prob(Stay) = \Phi(\beta_0 + \beta_1 CivMilGap + \beta_2 Demographic\ Variables + \beta_3 Military\ Experience\ Variables + \beta_4 Specialties'\ Dummy\ Variables + \beta_5 Fiscal\ Years'\ Dummy\ Variables + u) \quad (1)$$

Where:

*Prob(Stay)* = Probability of staying in the Navy, given personal financial and background characteristics

$\Phi$ = The standard normal cumulative distribution function

*CivMilGap* = Pay gap between civilian alternative compensation and military compensation for a given FY = (civilian pay – military pay)

Demographic variables include:

*female* = Physician being a female (male is the reference category)

*Black* = Physician being Black (White is the reference category)

*asian* = Physician being Asian (White is the reference category)

*hispanic* = Physician being Hispanic (White is the reference category)

*other* = Physician being a race other than White, Black, Asian, or Hispanic (White is the reference category)

*age* = Additional year of age

$age^2$ = Year of age squared

Military experience variables include:

*lt* = Physician currently holding the rank of lieutenant (commander is the reference category)

*lcdr* = Physician currently holding the rank of lieutenant commander (commander is the reference category)

*cpt* = Physician currently holding the rank of captain (commander is the reference category)

*YOS* = An additional year of service

$YOS^2$ = Year of service squared

*USUHS* = Physician accessed the Navy via USUHS (AFHPSP is the reference category)

*AFHPSP_DEF* = Physician accessed the Navy via AFHPSP-deferred (AFHPSP is the reference category)

*FAP* = Physician accessed the Navy via FAP (AFHPSP is the reference category)

*Specialties' dummy variables* = Physician practicing one of the 19 specialties included in the model (Anesthesiology is the reference category)

*Fiscal years' dummy variables* = Dummy variables for FY2002 through FY2022 (FY2002 is the reference category)

### *b. Specialty Groups Model*

Besides the main model, three additional probit regression models are estimated to examine effect of the pay gap on the retention of the three main groups of specialties:

- **Primary care specialties** – family practice, internal medicine, pediatrics, and occupational medicine.
- **Surgical specialties** – general surgery, neurological surgery, OB/GYN, ophthalmology, otolaryngology, orthopedic surgery, and urology.
- **Other specialties** – anesthesiology, dermatology, emergency medicine, neurology, pathology, physical medicine, psychiatry, and radiology.

The specification of specialty groups' models is similar to that of the main model in Equation (1). The number of observations for each specialty group, however, is limited to those of physicians who belong to that group.

### *c. Specialties-Specific Models*

In addition to the main model and specialty groups' models, 19 probit models are built to evaluate the effect of the civilian-military pay gap on the retention behavior of each specialty physicians. The results of these models, in addition to the results of the main model and the specialty groups' models, are used to obtain the overall elasticity estimate and the elasticity estimate of each individual specialty.

Due to the limited number of observation in some specialties, some of the explanatory variables predict the stay-leave decision perfectly. Therefore, the specification of specialties models is necessarily parsimonious compared to that of the main model and specialty groups' models. Specialties models are specified as shown in Equation (2):

$$Prob(Stay) = \Phi(\beta_0 + B_1\, CivMilGap + \beta_2 female + \beta_3 Minority + \beta_7 lt\_lcdr + \beta_8 YOS + \beta_9 YOS^2 + \beta_{10} age + \beta_{11} age^2 + \beta_{12} None\_AFHPSP + \beta_{13} Post\_2004 + u) \quad (2)$$

Where:

*Minority* = Physician being nonwhite (White is the reference category)

*lt_lcdr* = Physician currently holding the rank of lieutenant or lieutenant commander (commander or captain is the reference category)

*None AFHPSP* = Physician accessed the Navy via any accession program other than the AFHPSP (AFHPSP is the reference category)

*Post_2004* = A dummy variable that controls for time. Since some yearly dummy variables perfectly predict stay-leave decisions for few specialties, *(Post_2004)* is incorporated in specialty models. It equals (1) for FY2005 through FY2011, and (0) otherwise.

### *d. Secondary Model*

One of the secondary questions of this study examines the effect of the protracted GWOT on retention. Therefore, a secondary probit model is constructed to examine the retention rate before and after FY2004. This point in time is selected because, first, we do not have data prior to FY2001 in order to examine the retention before and after the tragedy of 9/11. Moreover, by the end of FY2004, it has been three years since the commencement of Operation Enduring Freedom (OEF) and almost 18 months since Operation Iraqi Freedom (OIF) was initiated. Therefore, the long-term effect of the GWOT is expected to be observed after 3–4 years of continuous combat operations. This second model is identical to the first model in Equation (1), except the FY dummies are replaced with a *Post_2004* dummy where:

*Post_2004* = A dummy variable that equals (1) for FY2005 through FY2011, and (0) otherwise.

To investigate whether a retention pattern varies systematically across specialty groups by the time or not, interactions between *Post_2004 dummy* and specialties' group dummies are incorporated in the secondary model. In addition, an interaction between *Post_2004* and *female* dummy variables is also included in the model to observe if the effect of the prolonged GWOT on retention differs across gender.

## 2. Variable Definitions and Expected Effects

### *a. Dependent Variable (STAY)*

The dependent variable is a binary variable that takes a value of (1) if a physician becomes unobligated at the beginning or during any given FY and decides to stay until the end of that FY. It also takes a value of (1) if he/she is observed as unobligated and decides to stay in the subsequent years that follow the year of his/her initial decision. The dependent variable is recorded as (0) for a physician who becomes unobligated at the beginning of or during any given FY and is not observed by the end of that FY. It also takes a value of (0) if a physician is not observed in any FY given that he/she was retained in the previous year. The end of active duty obligated service is obtained based on the OSD variable in the BUMED data.

### *b. Explanatory Variables*

(1) Civilian-Military Pay Gap. Civilian-military pay gap (*CivMilGap*) is the variable of interest. Other explanatory variables are controlled for and incorporated in the regression models in order to obtain an unbiased estimate of the effect of the civilian-military pay deferential on physicians' retention behavior. For each physician, in any given FY, the pay differential is calculated by summing the RMC (base pay, BAH, and BAS) and the Medical Corps' Special Pays (ASP, BCP, VSP, ISP, and MSP) and then subtracting the total from the equivalent civilian compensation. The civilian compensation data is obtained from MGMA's total physicians' compensation surveys from 2002 through 2011. To control for the effect of outlier observations, the

median of the civilian compensation is used in the calculation. Nevertheless, for the purpose of sensitivity analyses, the mean of the civilian compensation is also incorporated into an auxiliary model to observe if there is a significant difference in the effect of the civilian-military pay gap on retention when using the mean of the civilian compensation, rather than its median. Each Navy physician in the dataset is assigned to a civilian-military pay gap value based on FY, type of specialty, and number of years spent practicing as fully trained specialist. To facilitate the interpretation and obtain a practical significance of the pay gap effect on retention, the civilian-military pay gap is incorporated in the models as increments of $1,000.

It is expected that the pay gap will negatively affect the retention of unobligated, fully trained Navy physicians. The negative effect of the civilian-military pay gap is expected to be observed on the aggregate retention and on the retention probability of each individual specialty.

(2) Demographic Variables.

- **Gender (*male, female*).** Gender variable is a binary variable that is coded (1) if the physician is female and (0) otherwise. Male is the reference category in the regression models. Historically, females show a lower probability of retention than males. In modern societies, however, the responsibility of maintaining the family unit becomes less exclusive for females. Both parents share a solemn accountability to maintain the nature of the family unit. Therefore, it is expected that females are not statistically different than males with regard to their retention behavior. Moreover, it is also expected that females may have higher retention than males since the duty types and billets become less restrictive and the working conditions become more equitable for active duty female members, especially in the military medical field.
- **Race (*White, Black, Asian, Hispanic*, and *Other*).** Race categories are included in the regression models as dichotomous variables. If a physician belongs to one of these mutually exclusive categories, he/she is coded with (1), or (0) otherwise. The reference category in the regression models is White. Since the emergence of the All Volunteer Force (AVF), the proportion of racial minorities has significantly increased in the armed forces. Additionally, the military becomes a fair racial employer, where

job opportunities and chances for career advancement are distributed based on quality and productivity regardless of one's race or ethnicity. Therefore, compared to the civilian sector, minorities have a greater chance to progress in the military and may stay longer in the service than their White peers. Accordingly, the retention probability of nonwhite physicians is expected to be higher than that of White physicians in the aggregate model and in each specialty-specific model.

- **Age (*age*, and *age*$^2$).** Age is a continuous variable that represents a physician's age at the decision point. At younger ages, individuals are more likely to separate and switch jobs, either by quitting if they find themselves unmatched with their current job or as a result of a layoff if the employer finds them unfit for the job or with the organization overall. Moreover, younger employees are mostly single and they can easily mobilize and migrate to a different geographic region to look for a better job or a higher wage. On the other hand, older employees have a better understanding with regard to their optimal job matches and they already made their decision to stay in their current jobs. Furthermore, older employees are more likely to be married and have families, which restrain their ability to mobilize and switch jobs. Instead, they value job and income stability and stay longer than their younger peers. Therefore, it is expected that age affects retention negatively for younger physicians and the opposite happens for older physicians. To control for the diminishing return of age on retention, the age of a physician at the decision point is squared and incorporated in the regression models as ($age^2$) variable.

(3) Military Experience Variables.

- **Years of service (*YOS*, and *YOS*$^2$)**. A physician's accumulated credible military years of service at the decision point is represented by a continuous variable named (YOS). As a physician's YOS increases and he/she approaches retirement, they are more likely to stay up to 20 YOS in order to gain their retirement benefits. After 20 YOS, however, physicians are more likely to leave and pursue civilian employment. Thus, one additional YOS is expected to have a positive effect on retention up to 20 years; afterward, the effect is expected to invert and have a negative impact on retention behavior. A physician's YOS at the decision point is squared and included

in the regression models as the ($YOS^2$) variable in order to control for the diminishing return of YOS on retention.

- **Rank (*lt, lcdr, cdr,* and *cpt*).** Navy physicians' ranks are represented in the regression models with four binary variables: Lieutenant (*lt*), Lieutenant Commander (*lcdr*), Commander (*cdr*), and Captain (*cpt*). If a physician holds one of these ranks at the decision point, he/she is coded (1) for that given rank and (0) otherwise. The reference category in the regression models is Commander. The longer a physician stays in the Navy, the more likely he/she will be promoted, advanced, and earn higher pay. Therefore, it is expected that higher ranks are associated with a higher probability of retention.
- **Accession sources (*AFHPSP, AFHPSP_DEF, USUHS,* and FAP).** Accession sources are incorporated in the models as four dichotomous variables: the AFHPSP (*AFHPSP*), the Deferred AFHPSP (*AFHPSP_DEF*), the USUHS (*USUHS*), and the FAP (*FAP*). The reference category is AFHPSP. Many USUHS graduates have prior military service and they generally join the Navy with seven years of ADO to pay back for their medical school subsidies. Compared with other accession programs, USUHS physicians carry the longest initial ADO. This long tie with military life makes USUHS specialists more likely to stay in the Navy than physicians who accessed the Navy via different programs. On the other hand, AFHPSP- and AFHPSP-deferred physicians have four years of ADO for their school subsidies. However, AFHPSPs obtain their residency in military medical centers and carry additional ADO for their military residency, while AFHPSP-deferred physicians join the Navy after completing their residency in a civilian medical facility. Accordingly, AFHPSP specialists are more accustomed to Navy life and more likely to stay longer than AFHPSP-deferred specialists. FAP physicians, on the other hand, access the Navy during their civilian residency program and are obligated year-by-year of their residency program length. They typically have an ADO of 3–4 years. As soon as they get unobligated, they are more likely to leave than other accession source program's

specialists since they have the least military life engagement. Thus, it is expected to observe a higher retention probability for USUHS specialists than that of the AFHPSP, while AFHPSP-deferred and FAP specialists are expected to have a lower retention probability than AFHPSP specialists.

(4) Years Dummy Variables. The year in which the unobligated physicians had to make the decision is captured by the set of year dummy variables for FY2002 through FY2011. These year dummies control for unobservable secular trend in retention rates that are not related to differences in pay gap. FY2002 is the reference category.

(5) Specialties Dummy Variables. Specialties' dummy variables are included in the regression models to control for and eliminate the effect of each of the retention differences across specialties. Anesthesiology is the reference category for the main model as well as the other specialties group model. Family practice is the reference category for the primary care specialties group model, while general surgery is the reference category for the surgical group model.

Table 7 shows a summary of all explanatory variables and their expected effect on physicians' retention.

Table 7. Explanatory Variables and Expected Signs.

| Variable Name | Variable Type | Expected Sign |
|---|---|---|
| **Variable of Interest** | | |
| *CivMilGap* | Continuous | – |
| **Demographic** | | |
| **Gender** | | |
| *male* | Dichotomous | Reference Category |
| *female* | Dichotomous | + |
| **Race/Ethnicity** | | |
| *white* | Dichotomous | Reference Category |
| *black* | Dichotomous | + |
| *hispanic* | Dichotomous | + |
| *asian* | Dichotomous | + |
| *other* | Dichotomous | + |
| **Age** | | |
| *age* | Continuous | – |
| $age^2$ | Continuous | + |

| Variable Name | Variable Type | Expected Sign |
|---|---|---|
| **Military Experience** | | |
| **Rank** | | |
| *lt* | Dichotomous | – |
| *lcdr* | Dichotomous | – |
| *cdr* | Dichotomous | Reference Category |
| *cpt* | Dichotomous | + |
| **Years of Service** | | |
| *YOS* | Continuous | – |
| $YOS^2$ | Continuous | + |
| **Accession Source** | | |
| *AFHPSP* | Dichotomous | Reference Category |
| *AFHPSP_DEF* | Dichotomous | – |
| *USUHS* | Dichotomous | + |
| *FAP* | Dichotomous | – |

## B. PROJECTION ANALYTICAL METHODS

Utilizing the Main probit regression model in Equation (1) to predict Navy Medical Corps' future retention rates is the most appropriate method of projection. However, the absence of Medical Corps' inventory data for FY2012 and beyond restrains the employment of the probit model to forecast future retention rates. The best alternative projection method is to implement univariate time-series models to estimate future retention rates based on the historical data. BUMED records Navy Medical Corps' inventory on a yearly basis. Therefore, based on the dataset we have (FY2002 until FY2011), only 10 observations are available with regard to yearly retention rates. With such limited availability of historical data, time-series smoothing models are the adequate models to predict future retention rates. Smoothing models require stationary data to forecast; accordingly, the Autocorrelation and Partial Autocorrelation Functions (ACF, PACF) of retention rates are tested and they indicate that the aggregate retention rates, as well as the retention rates of each individual specialty for the past 10 years, show stationary patterns. Therefore, we are able to employ time-series smoothing models to forecast future retention rates since the stationary data condition is satisfied.

Three techniques are utilized to predict the retention rates for FY2012: forecasting with the mean, forecasting with moving average, and exponential smoothing forecast.

The mean forecasting method predicts future retention rates based on the average of all historical retention rate data. The model used for projection based on the mean forecasting method is:

$$F_{t+1} = (\frac{A_1+A_2+\cdots+A_t}{T}),$$

where $F_{t+1}$ = Forecast for time period (t+1)

$A_{1-t}$ = Data (observations) for periods *1* to *t*

$T$ = The total number of time periods.

Forecasting with moving average predicts the future retention rates based on the average of past *n* observations instead of the average of all historical data. In this study, three periods moving average and four periods moving average are used. Forecasting with moving average models are:

$$F_{t+1} = \sum_{t=1}^{t} A_t/n,$$

where $A_t$ = Data (observation) for period *t*

*n* = The number of past observations.

Exponential smoothing forecasting method predicts the future retention rates as a weighted average of the actual retention rates in period *t*, *(t-1)*, *(t-2)*, etc. The weight associated with a period's actual retention rate decreases exponentially over time. The exponential smoothing forecasting model is:

$$F_{t+1}=F_t+\alpha \times (A_t-F_t),$$

where $A_t$ = Actual value for period *t*

$F_t$ = Forecasted value for period *t*

$\alpha$ = A smoothing constant that has a value between (0) and (1).

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# V. RESULTS

## A. INTRODUCTION

The main focus of this study is to examine the effect of the civilian-military pay gap on the retention of the Navy's unobligated, fully trained specialists. All other explanatory variables are controlled to obtain an unbiased estimator of the pay differential on physicians' retention. A main probit regression model is constructed to measure the effect of the pay gap on the aggregate retention of the Navy's specialists who become unobligated from FY2002 through FY2011. In addition, separate probit regression models are utilized to investigate the effect of the civilian-military pay gap on the retention for the three main specialty groups (primary care, surgical specialties, and other specialties) and for 19 individual specialties. The results of the regression models are reported and discussed in this chapter. The partial effect of the pay differential is used to calculate the overall retention elasticity and the elasticity estimates of each specialty.

A secondary question of this study seeks to understand the effect of the protracted GWOT on the retention behavior of the Navy's Medical Corps. Therefore, a secondary probit regression model is constructed to evaluate the effect of that prolonged conflict on the retention of Navy physicians in the last decade. The final part of this chapter discusses the results of a forecasting model that predict the overall retention rate and the retention rate for each specialty.

## B. MULTIVARIATE MODELS' STRENGTH

### 1. Global Null Hypothesis

The global null hypothesis tests whether at least one explanatory variable in a regression model explains the variation in the dependent variable. Here, the dependent variable is (STAY). The null hypothesis is that all the coefficients of the explanatory variables equal zero, which implies that none of the independent variable have an effect on the dependent variable. The alternative hypothesis is that at least one explanatory variable explains the variation in the dependent variable and its coefficient does not equal zero.

In a probit regression model, the Wald statistic (chi-square) can determine the explanatory power of the model. Based on its P-value (Pr>chi-sq.) we can reject or accept the global null hypothesis. In all of the probit models utilized in this study, we are able to reject the null hypothesis and conclude that at least one of the explanatory variables explains the variation in the dependent variable (STAY) at a significant level of 0.1 or less, except for pathology and neurology, as their models do not yield significant Wald statistics due to their limited number of observations. In addition, we are not able to construct regression models and conduct statistical analyses for neurological surgeons and physical/rehabilitation specialists, since their number of observations are below 30. Table 8 represents the values of Wald statistic and its p-value, as well as the maximum likelihood ratio for all models used in this study.

Table 8. Global Null Hypothesis Test for Probit models.

| Model | Likelihood Ratio | Chi-Squared | DF | Pr>Chisq | Pseudo R-Squared |
|---|---|---|---|---|---|
| Main model | –2507.569 | 631.83 | 43 | 0.0000 | 0.1119 |
| Primary Care Specialties | –934.608 | 238.18 | 28 | 0.0000 | 0.1130 |
| Surgical Specialties | –603.148 | 283.49 | 31 | 0.0000 | 0.1903 |
| Other Specialties | –904.889 | 239.97 | 32 | 0.0000 | 0.1171 |
| Anesthesiology | –227.241 | 29.26 | 9 | 0.0006 | 0.0605 |
| General Surgery | –105.135 | 56.09 | 9 | 0.0000 | 0.2106 |
| Neurological Surgery | There are not enough observations to conduct the model | | | | |
| OB/GYN | –186.603 | 73.35 | 8 | 0.0000 | 0.1643 |
| Ophthalmology | –48.107 | 23.03 | 8 | 0.0033 | 0.1932 |
| Orthopedic Surgery | –152.796 | 50.95 | 9 | 0.0000 | 0.1429 |
| Otolaryngology | –51.513 | 39.36 | 8 | 0.0000 | 0.2764 |
| Urology | –53.126 | 11.48 | 6 | 0.0746 | 0.0975 |
| Occupational Medicine | –49.120 | 17.93 | 8 | 0.0218 | 0.1543 |
| Physical and Rehabilitation | There are not enough observations to conduct the model | | | | |
| Pathology | –64.649 | 11.22 | 8 | 0.1897 | 0.0798 |
| Dermatology | –78.579 | 27.08 | 9 | 0.0014 | 0.1470 |
| Emergency Medicine | –232.011 | 49.14 | 8 | 0.0000 | 0.0958 |
| Family Practice | –528.397 | 110.04 | 9 | 0.0000 | 0.0943 |
| Internal Medicine | –160.748 | 52.97 | 9 | 0.0000 | 0.1415 |
| Neurology | –21.358 | 14.05 | 9 | 0.1206 | 0.2475 |
| Pediatrics | –195.172 | 59.12 | 10 | 0.0000 | 0.1315 |
| Psychiatry | –123.255 | 34.00 | 9 | 0.0001 | 0.1212 |
| Radiology | –154.573 | 51.62 | 9 | 0.0000 | 0.1431 |
| Secondary Model | –2517.716 | 611.54 | 38 | 0.0000 | 0.1083 |

### 2. Pseudo R-Squared

The traditional R-squared of OLS models ranges between 0 and 1, and measures the proportion of the variation in the dependent variable that is explained by the variation in the explanatory variables. Because of the nature of the binary dependent variable in probit models, R-squared is not applicable. Instead, McFadden's pseudo R-squared is utilized. Pseudo R-squared also ranges between 0 and 1; however, the methodology used to calculate it is different than that of the basic R-squared.[10] Pseudo R-squared indicates whether the model is better explained by including all independent variables or having none of them in the model. Table 8 depicts the values of pseudo R-squared of all probit models employed in this study.

## C. MAIN MODEL RESULTS

The results of the main model are presented in Table 9. The probit column shows the direction of the effect of the explanatory variables on the overall physicians' retention, while the marginal effect column shows the magnitude of the effect on the overall retention probability associated with each explanatory variable and is measured for the reference physician. The reference physician is a White, male anesthesiologist who accessed the Navy through AFHPSP. He holds the rank of Commander, is approximately 39 years old, and has almost 11 years of accumulated military service. He faces a pay gap of $98,787.40 and has a 68% probability of staying in the Navy.

Table 9. Main Model Results.

| Variables | Main Model | |
|---|---|---|
| | **Probit** | **Marginal Effect** |
| *CivMilGap* | –0.00466*** | –0.00161*** |
| *(in $1000 increment)* | (0.000797) | (0.000274) |
| *Female* | –0.117** | –0.0408** |
| | (0.0511) | (0.0181) |
| *Male* | **Reference Category** | |

[10] Pseudo R-squared = 1- $\frac{ln\,E\hat{}(model\ with\ all\ regressors}{ln\,E\hat{}(model\ without\ regressors}$, where: ln = natural log; $E\hat{}$=the estimated likelihood. OLS R-squared = 1- $\frac{SSR}{TSS}$, where: SSR=sum of squared residuals; TSS=total sum of squares for the dependent variable.

| Variables | Main Model | |
|---|---|---|
| *Black* | –0.601*** | –0.227*** |
| | (0.0763) | (0.0299) |
| *Asian* | 0.0994 | 0.0335 |
| | (0.103) | (0.0337) |
| *Hispanic* | 0.0477 | 0.0163 |
| | (0.139) | (0.0467) |
| *Other* | –0.590*** | –0.224*** |
| | (0.104) | (0.0413) |
| *White* | **Reference Category** | |
| *Lt* | –0.178 | –0.0636 |
| | (0.145) | (0.0538) |
| *Lcdr* | –0.546*** | –0.177*** |
| | (0.0805) | (0.0242) |
| *Cpt* | –0.0680 | –0.0238 |
| | (0.103) | (0.0365) |
| *Cdr* | **Reference Category** | |
| *YOS* | –0.136*** | –0.0469*** |
| | (0.0229) | (0.00791) |
| $YOS^2$ | 0.00207*** | 0.000716*** |
| | (0.000716) | (0.000247) |
| *Age* | –0.219*** | –0.0756*** |
| | (0.0579) | (0.0200) |
| $age^2$ | 0.00259*** | 0.000894*** |
| | (0.000694) | (0.000240) |
| *USUHS* | 0.142** | 0.0478** |
| | (0.0649) | (0.0211) |
| *AFHPS_DEF* | –0.490*** | –0.179*** |
| | (0.0702) | (0.0265) |
| *FAP* | –0.480** | –0.182** |
| | (0.202) | (0.0804) |
| *AFHPSP* | **Reference Category** | |
| *InternalMedicine* | –0.685*** | –0.261*** |
| | (0.155) | (0.0606) |
| *OccupMedicine* | –0.221 | –0.0801 |
| | (0.192) | (0.0724) |
| *Pediatrics* | –0.683*** | –0.260*** |
| | (0.157) | (0.0614) |
| *FamilyPrac* | –0.613*** | –0.226*** |
| | (0.143) | (0.0545) |
| *GenSurg* | –0.0710 | –0.0249 |
| | (0.125) | (0.0447) |
| *NeuroSurg* | 0.974*** | 0.232*** |
| | (0.327) | (0.0425) |
| *OBGYN* | –0.307** | –0.112** |
| | (0.124) | (0.0475) |
| *Ophthal* | –0.0463 | –0.0162 |
| | (0.165) | (0.0583) |

| Variables | Main Model | |
|---|---|---|
| *OrthoSurg* | 0.455*** | 0.138*** |
| | (0.128) | (0.0327) |
| *Otolary* | 0.0633 | 0.0215 |
| | (0.153) | (0.0512) |
| *Urology* | –0.0680 | –0.0239 |
| | (0.164) | (0.0584) |
| *PhyRehab* | –0.0969 | –0.0343 |
| | (0.342) | (0.124) |
| *Pathology* | 0.339** | 0.106*** |
| | (0.148) | (0.0410) |
| *Dermatology* | 0.130 | 0.0435 |
| | (0.136) | (0.0436) |
| *EmergencyMedicine* | –0.204* | –0.0734 |
| | (0.121) | (0.0450) |
| *Neurology* | –0.473** | –0.179** |
| | (0.228) | (0.0907) |
| *Psychiatry* | –0.590*** | –0.224*** |
| | (0.159) | (0.0627) |
| *DiagRadiology* | 0.455*** | 0.138*** |
| | (0.128) | (0.0328) |
| *Anesth* | **Reference Category** | |
| *fy03* | 0.163* | 0.0544* |
| | (0.0901) | (0.0289) |
| *fy04* | 0.227*** | 0.0748*** |
| | (0.0860) | (0.0268) |
| *fy05* | 0.0942 | 0.0319 |
| | (0.0864) | (0.0286) |
| *fy06* | –0.135 | –0.0479 |
| | (0.0879) | (0.0319) |
| *fy07* | 0.0191 | 0.00657 |
| | (0.0936) | (0.0321) |
| *fy08* | –0.243** | –0.0880** |
| | (0.0969) | (0.0366) |
| *fy09* | –0.174* | –0.0625* |
| | (0.100) | (0.0371) |
| *fy10* | –0.253** | –0.0920** |
| | (0.101) | (0.0383) |
| *fy11* | –0.0946 | –0.0334 |
| | (0.107) | (0.0387) |
| *Fy02* | **Reference Category** | |
| *Constant* | 7.474*** | |
| | (1.144) | |
| | | |
| Observations | 4,478 | 4,478 |
| Standard errors in parentheses<br>*** p<0.01, ** p<0.05, * p<0.1 | | |

In the main model, the effect of the civilian-military pay gap on the aggregate retention probability is negative and statistically significant at a 0.01 level. A $1,000 increase in the pay gap above the average reduces the probability to stay by 0.00161 (i.e., 0.16 percentage point). This is equivalent to a 0.24% reduction in retention rate (0.16 percentage point reduction divided by the baseline retention rate of 68%). In other words, if the average pay gap (currently at $98,787.4) is reduced to zero, the retention rate would increase by 23.5% (98787.4×0.0000024=0.235). Accordingly, closing the pay gap would increase the average retention rate for the sample from 68% to 84%.

Female physicians have a lower likelihood to stay in the Navy by 0.04 percentage point than males. This is found to be statically significant at a level of 0.05. A Black physician is less likely to stay in the Navy by 23 percentage points relative to a White physician. This result is statistically significant at a 0.01 level. The retention behavior of Asian or Hispanic physicians is not statistically different when compared to the retention behavior of White physicians.

Lieutenants are 6.4 percentage points less likely to stay in the Navy than Commanders. This result, however, is statistically insignificant. Lieutenant Commanders are less likely to stay in the Navy by 17.7 percentage points than Commanders. This is statistically significant at a level of 0.01. On the other hand, the retention behavior of physicians who hold the rank of Captain is not statistically different than the retention behavior of physicians who hold the rank of Commander.

YOS is found to be statistically significant at a level of 0.01 and negatively affect the retention probability. In contrast, $YOS^2$ has a positive effect on the aggregate retention behavior. This effect is statistically significant at level of 0.01. These results confirm that YOS has a diminishing return on the retention probability, especially in that both variables (*YOS* and $YOS^2$) are jointly significant. To investigate the exact point at which the effect of YOS is inverted, the following formula is utilized: $\beta_1 \div 2(\beta_1) = 0.0469 \div 2(0.000716) = 32.8$. Accordingly, YOS has a negative, but diminishing, effect on retention until 32.8 years of accumulated service, and then the effect becomes positive. Age variables (*age* and $age^2$) are individually and jointly significant at level of 0.01. Age affects retention negatively, while $age^2$ has a positive effect on retention. This indicates a

diminishing return of age on the retention behavior. To calculate the turning point at which age affects retention positively, the following formula is employed: $\beta_1 \div 2(\beta_1) = 0.0756 \div 2(0.000894) = 42.3$ years. Therefore, age affects retention negatively, but at decreasing rate up to 42.3 years. Then, the effect of age on retention becomes positive for each additional year.

Physicians assessed through USUHS have a greater probability of staying in the Navy by 4.8 percentage points than physicians assessed through AFHPSP. In contrast, physicians who joined the Navy through AFHPSP deferred or FAP are less likely to stay than AFHPSP physicians by 17.9 and 18.2 percentage points, respectively. Both results are statistically significant at a 0.01 level. These findings confirm the expectations that USUHS physicians are more likely to be retained, since many of them have prior military experience and are initially obligated for a longer time than other physicians. On the other hand, AFHPSP-deferred and FAP physicians join the Navy as fully trained specialists and have fewer years of obligation than AFHPSP or USUHS physicians. Therefore, they have the least military life experience and are more likely to leave.

Specialties' indicators show that the majority of physicians practicing specialties other than anesthesiology are not statistically different than anesthesiologists with respect to their retention behavior. Pathologists, radiologists, neurological surgeons, and orthopedic surgeons, however, have a higher retention probability than anesthesiologists by 10.6, 13.8, 23.2, and 13.8 percentage points, respectively. On the other hand, internal medicine specialists, pediatricians, family practitioners, OB/GYN specialists, neurologists, and psychiatrists have a retention probability that ranges between 11.2 and 26.1 percentage points less than that of anesthesiologists.

## D. RESULTS OF THE PRIMARY CARE SPECIALISTS' MODEL

This model evaluates the retention behavior of primary care specialists who became unobligated from FY2002 through FY2011. The primary care specialists group includes family practice specialists, pediatricians, occupational medicine specialists, and internal medicine specialists. The results of the primary care specialists' model is

presented in Table 10. The probit column in Table 10 shows the direction and the significance of the explanatory variables, while the marginal effect column presents the partial effect of each explanatory variable. The partial effect is evaluated for the reference physician in the sample. The reference primary care physician is a White, male, family practitioner who accessed the Navy through AFHPSP and holds the rank of Commander. He has 10.5 years of accumulated service and is 38.7 years old. He faces a pay gap of $26,490.80 and has a 68% probability of staying in the service.

The effect of the civilian-military pay gap has a negative impact on primary care specialists' retention. A $1,000 increase in the pay gap above the average reduces the probability of staying by 0.76 percentage point than that of the reference person. Commensurately, a $1,000 increase in the pay gap reduces the retention rate of primary care physicians by 1.1% (0.76 percentage point reduction divided by the baseline retention rate of 68%). This result is significant at a level of 0.01. If the pay gap of primary care physicians is reduced to zero, their probability to stay will increased by 29.7% (26490.8*0.0000112=0.297). Accordingly, closing the pay gap would increase the average retention rate for the sample from 68% to 88.2%.

Compared to the main model, race, gender, and YOS have similar effects when restricting the analysis to the primary care group. The effect of age on the retention of primary care specialists, however, is found to be statistically insignificant.

Primary care specialists who hold the rank of Lieutenant Commander or Captain are less likely to stay in the Navy than Commanders by 22 and 15 percentage points, respectively. Lieutenants, however, are not different than Commanders with regard to their retention behavior.

The difference in accession source has a similar effect on the retention of primary care specialists, compared to the findings of the main model, except that the retention behavior of physicians who accessed the Navy through FAP and AFHPSP-deferred is no different than that of those who join the Corps through the AFHPSP, when restricting the analysis to the primary care group.

## E. RESULTS OF SURGICAL SPECIALTIES' MODEL

A separate probit model is constructed to evaluate the retention behavior of the surgical specialists group. This group includes general surgery, neurological surgery, OB/GYN, ophthalmology, otolaryngology, orthopedic surgery, and urology. The results of surgical group model are presented in Table 10. The reference physician for this group is a White, male, general surgeon who joined the Navy through the AFHPSP and holds the rank of Commander. He has 10.05 years of service and is 38.64 years of age. He faces a pay gap of $151,535 and is 68% likely to stay in the Navy.

The civilian-military pay gap negatively affects the retention behavior of surgical specialists. A $1,000 increase in the pay gap above the average reduces the probability to stay by 0.14 percentage point less than that of the reference physician. This is equivalent to 0.21% reduction in the retention rate of the sample (0.14 percentage point reduction divided by the baseline retention rate of 68%). This result is significant at a level of 0.01. If the pay gap of surgical specialists is reduced to zero, their probability to stay will increase by 31.4% (151535*0.00000207=0.314). Accordingly, if the average retention probability for surgeons is 68%, closing the pay gap to zero will increase retention up to 89.4%.

Despite that the retention probability of female surgeons is not statistically different than that of male surgeons, other demographic and military experience variables have a similar effect on the retention behavior when restricting the analysis to the surgical specialties' group compared to the results of the main model.

## F. RESULTS OF OTHER SPECIALTIES' MODEL

A separate probit model is created to evaluate the retention behavior of physicians with specialties other than primary care and surgery. This group of specialties includes anesthesiology, dermatology, emergency medicine, neurology, pathology, physical medicine, psychiatry, and radiology. The results of the other specialties group's model is presented in Table 10. The reference physician for this group is a White, male anesthesiologist who joined the Navy through the AFHPSP and holds the rank of Commander. He has 12 years of service with an age of 40.3 years. The reference

physician for this group faces a pay gap of $134,886 and has a retention probability of 67%.

The civilian-military pay gap negatively affects the retention behavior of other specialties physicians. A $1,000 increase in the pay gap above the average reduces the probability to stay by 0.094 percentage point less than that of the reference person of this group. This is equivalent to 0.14% reduction in the retention rate of this group (0.094 percentage point reduction divided by the baseline retention rate of 67%). This result is significant at a level of 0.05. If the average pay gap of the other specialties group is reduced to zero, their probability to stay will increase by 18.9% (134886* 0.00000140=0.189). Accordingly, closing the pay gap to zero will increase retention for other specialties' physicians from 67% to 79.7%.

Compared to the findings of the main model, demographic variables have a similar effect on the retention behavior when restricting the sample to other specialties group. Females in this group, however, are not statistically different than males with respect to their retention. Likewise, the effect of age on retention is found to be statistically insignificant for this group.

The effect of military experience variables on the retention behavior of other specialties physicians is also similar to that of the main model except that the retention behavior of specialists who accessed the Navy through the USHUS program in this group is not statistically different than of those who joined the Corps through the AFHPSP.

Table 10. Primary Care, Surgical Specialties, and Other Specialties Models Results.

| Variables | Primary Care Model | | Surgical Specialties Model | | Other Specialties Model | |
|---|---|---|---|---|---|---|
| | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** |
| *CivMilGap* | –0.0219*** | –0.00758*** | –0.00438*** | –0.00141*** | –0.00273** | –0.000944** |
| *(in $1000 increment)* | (0.00342) | (0.00118) | (0.00159) | (0.000510) | (0.00112) | (0.000386) |
| *female* | –0.139* | –0.0486* | 0.0170 | 0.00545 | –0.148 | –0.0523 |
| | (0.0762) | (0.0269) | (0.116) | (0.0373) | (0.0910) | (0.0329) |
| *male* | **Reference Category** | | | | | |
| *black* | –0.529*** | –0.199*** | –0.277* | –0.0953* | –1.096*** | –0.416*** |
| | (0.118) | (0.0462) | (0.145) | (0.0526) | (0.152) | (0.0533) |
| *asian* | 0.0271 | 0.00934 | 0.0728 | 0.0229 | 0.0702 | 0.0239 |

| Variables | Primary Care Model | | Surgical Specialties Model | | Other Specialties Model | |
|---|---|---|---|---|---|---|
| | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** |
| | (0.171) | (0.0585) | (0.275) | (0.0846) | (0.150) | (0.0501) |
| *hispanic* | –0.0143 | –0.00496 | 0.00161 | 0.000519 | 0.139 | 0.0462 |
| | (0.264) | (0.0922) | (0.290) | (0.0933) | (0.208) | (0.0665) |
| *other* | –0.815*** | –0.313*** | –0.381** | –0.134** | –0.558*** | –0.212*** |
| | (0.178) | (0.0683) | (0.188) | (0.0712) | (0.186) | (0.0739) |
| *white* | **Reference Category** | | | | | |
| *lt* | –0.337 | –0.124 | 0.171 | 0.0524 | 0.104 | 0.0350 |
| | (0.233) | (0.0893) | (0.418) | (0.120) | (0.292) | (0.0958) |
| *lcdr* | –0.687*** | –0.218*** | –0.503*** | –0.151*** | –0.501*** | –0.165*** |
| | (0.161) | (0.0456) | (0.154) | (0.0425) | (0.124) | (0.0386) |
| *cpt* | –0.400** | –0.148** | 0.160 | 0.0493 | –0.0713 | –0.0250 |
| | (0.187) | (0.0725) | (0.224) | (0.0656) | (0.160) | (0.0568) |
| *cdr* | **Reference Category** | | | | | |
| *YOS* | –0.133*** | –0.0461*** | –0.225*** | –0.0725*** | –0.173*** | –0.0598*** |
| | (0.0361) | (0.0125) | (0.0497) | (0.0158) | (0.0351) | (0.0121) |
| $YOS^2$ | 0.00169* | 0.000584* | 0.00391** | 0.00126** | 0.00388*** | 0.00134*** |
| | (0.00102) | (0.000352) | (0.00160) | (0.000513) | (0.000989) | (0.000341) |
| *age* | 0.0157 | 0.00543 | –0.421*** | –0.136*** | –0.0116 | –0.00402 |
| | (0.0126) | (0.00436) | (0.126) | (0.0403) | (0.0132) | (0.00457) |
| $age^2$ | Omitted since age and $age^2$ are not jointly significant | | 0.00480*** | 0.00155*** | Omitted since age and $age^2$ are not jointly significant | |
| | | | (0.00149) | (0.000476) | | |
| *USUHS* | 0.271** | 0.0878** | 0.297** | 0.0889** | 0.0263 | 0.00906 |
| | (0.122) | (0.0368) | (0.133) | (0.0367) | (0.0977) | (0.0335) |
| *AFHPS_DEF* | –0.0183 | –0.00635 | –1.219*** | –0.428*** | –0.530*** | –0.196*** |
| | (0.118) | (0.0412) | (0.178) | (0.0608) | (0.122) | (0.0465) |
| *FAP* | –0.299 | –0.111 | –0.568 | –0.208 | –0.653* | –0.250* |
| | (0.372) | (0.144) | (0.357) | (0.141) | (0.356) | (0.141) |
| *AFHPSP* | **Reference Category** | | | | | |
| *InternalMedicine* | 0.0307 | 0.0106 | | | | |
| | (0.0957) | (0.0328) | | | | |
| *OccupMedicine* | 0.627*** | 0.179*** | | | | |
| | (0.171) | (0.0376) | | | | |
| *Pediatrics* | –0.0675 | –0.0236 | | | | |
| | (0.0916) | (0.0324) | | | | |
| *FamilyPrac* | **Reference Category** | | | | | |
| *NeuroSurg* | | | 1.134** | 0.226*** | | |
| | | | (0.547) | (0.0496) | | |
| *OBGYN* | | | –0.531*** | –0.181*** | | |
| | | | (0.149) | (0.0523) | | |
| *Ophthal* | | | –0.0802 | –0.0264 | | |
| | | | (0.194) | (0.0652) | | |
| *OrthoSurg* | | | 0.476* | 0.140** | | |
| | | | (0.252) | (0.0659) | | |
| *Otolary* | | | 0.0543 | 0.0172 | | |
| | | | (0.188) | (0.0589) | | |

| Variables | Primary Care Model | | Surgical Specialties Model | | Other Specialties Model | |
|---|---|---|---|---|---|---|
| | Probit | Marginal Effect | Probit | Marginal Effect | Probit | Marginal Effect |
| *Urology* | | | –0.0125 | –0.00403 | | |
| | | | (0.201) | (0.0650) | | |
| *GenSurg* | | | **Reference Category** | | | |
| *PhyRehab* | | | | | 0.0192 | 0.00661 |
| | | | | | (0.356) | (0.122) |
| *Pathology* | | | | | 0.449*** | 0.137*** |
| | | | | | (0.154) | (0.0402) |
| *Dermatology* | | | | | 0.140 | 0.0468 |
| | | | | | (0.139) | (0.0448) |
| *EmergencyMed* | | | | | –0.0394 | –0.0137 |
| | | | | | (0.141) | (0.0492) |
| *Neurology* | | | | | –0.245 | –0.0894 |
| | | | | | (0.246) | (0.0936) |
| *Psychiatry* | | | | | –0.319 | –0.116 |
| | | | | | (0.194) | (0.0735) |
| *DiagRadiology* | | | | | 0.293** | 0.0956** |
| | | | | | (0.143) | (0.0436) |
| *Anesth* | | | | | **Reference Category** | |
| *fy03* | –0.0747 | –0.0262 | 0.0127 | 0.00409 | 0.508*** | 0.155*** |
| | (0.148) | (0.0528) | (0.183) | (0.0584) | (0.159) | (0.0412) |
| *fy04* | 0.0163 | 0.00563 | 0.108 | 0.0338 | 0.494*** | 0.152*** |
| | (0.144) | (0.0495) | (0.177) | (0.0539) | (0.145) | (0.0383) |
| *fy05* | –0.158 | –0.0562 | 0.0614 | 0.0195 | 0.290** | 0.0940** |
| | (0.143) | (0.0522) | (0.184) | (0.0574) | (0.142) | (0.0427) |
| *fy06* | –0.359** | –0.132** | –0.186 | –0.0627 | 0.0611 | 0.0209 |
| | (0.143) | (0.0548) | (0.191) | (0.0669) | (0.146) | (0.0491) |
| *fy07* | –0.188 | –0.0677 | 0.198 | 0.0603 | 0.201 | 0.0664 |
| | (0.157) | (0.0581) | (0.206) | (0.0587) | (0.152) | (0.0477) |
| *fy08* | –0.452*** | –0.169*** | –0.0383 | –0.0125 | –0.139 | –0.0494 |
| | (0.154) | (0.0602) | (0.219) | (0.0720) | (0.161) | (0.0590) |
| *fy09* | –0.543*** | –0.205*** | 0.0182 | 0.00582 | 0.0566 | 0.0193 |
| | (0.163) | (0.0643) | (0.213) | (0.0678) | (0.168) | (0.0566) |
| *fy10* | –0.571*** | –0.216*** | –0.216 | –0.0735 | –0.0729 | –0.0256 |
| | (0.168) | (0.0665) | (0.222) | (0.0794) | (0.166) | (0.0591) |
| *fy11* | –0.324* | –0.120* | –0.182 | –0.0614 | 0.145 | 0.0483 |
| | (0.173) | (0.0668) | (0.245) | (0.0868) | (0.174) | (0.0558) |
| *Fy02* | **Reference Category** | | | | | |
| *Constant* | 2.495*** | | 12.69*** | | 3.031*** | |
| | (0.478) | | (2.540) | | (0.535) | |
| Observations | 1,673 | 1,673 | 1,183 | 1,183 | 1,622 | 1,622 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In summary, it appears that the civilian-military pay gap exists and negatively affects the retention of unobligated, fully trained Navy physicians. The magnitude of the pay gap effect varies across groups of specialties. On the whole, an additional $1,000 in the pay gap reduces the retention probability by 0.24%. This effect is mostly driven by the retention responsiveness of the primary care specialists for the same amount of pay gap increase (1.1%). The other specialties group shows the least responsiveness to the pay gap (0.14%) in terms of retention. The effect of the pay gap, however, is measured at the average values of the explanatory variables of the sample, which vary from one group of specialties to another. The adequate way to measure the propensity of the pay gap effect across specialties is by obtaining the retention-pay gap elasticity for each specialty, which will be discussed in detail in Section G.

## G. ELASTICITY OF RETENTION

The aggregate retention elasticity and the elasticity of each specialty group as well as the elasticity of 19 individual specialties are presented in Table 11. The elasticity represents the percentage change in retention rate for every 1% change in pay gap. To calculate the elasticity estimate, the following elasticity formula is employed:

$$\varepsilon = \beta_1 \times (\overline{CivMilGap} \div P),$$

where: $\varepsilon$ = the elasticity estimate

$\beta_1$ = the coefficient of (civilian-military pay gap)

$\overline{CivMilGap}$ = Mean of the civilian-military pay gap

$P$ = Probability of retention for the sample.

In order to obtain the elasticity estimates for 19 individual specialties, a separate probit model is built for each specialty. The results of the specialties-specific models are presented in Appendix A.

Table 11. Elasticity of Retention with Respect to the Pay Gap.

| Specialty | Elasticity |
|---|---|
| Overall retention | –0.24*** |
| Primary Care Specialties | –0.30*** |
| Family Practice | –0.37* |
| Internal Medicine | –0.51** |
| Pediatrics | –0.19*** |
| Occupational Medicine | –0.06 |
| Surgical Specialties | –0.31*** |
| General Surgery | –0.76** |
| Neurological Surgery | N/A |
| Orthopedic Surgery | –0.68* |
| OB/GYN | –1.42*** |
| Ophthalmology | –0.42 |
| Otolaryngology | –1.0* |
| Urology | –0.45* |
| Other Specialties | –0.19** |
| Anesthesiology | –0.54** |
| Dermatology | –0.14 |
| Emergency Medicine | –0.50** |
| Neurology | 0.75 |
| Pathology | 0.07 |
| Physical and Rehabilitation | N/A |
| Psychiatry | –0.46*** |
| Radiology | –0.74*** |

*** p<0.01, ** p<0.05, * p<0.1
(N/A) Not Applicable, since there are no enough observations to conduct the analysis.

It appears that Navy's unobligated specialists are modestly sensitive to the civilian-military pay gap. Their overall retention elasticity is (–0.24), which indicates a 0.24% reduction in the retention probability for each 1% increase in the pay gap or vice versa. Accordingly, if the pay gap is reduced by 100%, the total retention probability will increase by 24%. If the average retention probability for Navy's unobligated, fully trained physicians is 68%, then by closing the pay gap to zero, the retention probability will increase to 84.3%.

Surgical specialties group shows the highest retention-pay gap elasticity (–0.314), while the other specialties group exhibits the least retention responsiveness to the civilian-military pay gap with an elasticity of (–0.19).

With regard to the individual specialties, OB/GYN specialists are the most sensitive to the pay gap with an elasticity of (–1.42), while occupational medicine specialists show the least responsiveness to the pay gap with an elasticity of (–0.06). The later result, however, is statistically insignificant.

## H. SECONDARY MODEL RESULTS

One of the secondary questions of this study seeks to understand the effect of the protracted GWOT on retention in the Navy's Medical Corps. For this purpose, a secondary probit model is constructed. The variable of interest in this model is (*post_2004*), which is a time dummy variable that has a value of (1) for FYs from 2005 until 2011 and a value of (0) otherwise. Historically, active duty members showed higher rates of retention in the early years that followed the tragedy of 9/11. This increase in retention is attributed to an increase in patriotism, which led to a commitment for staying on active duty to protect the nation. Chapter II of this study discusses prior studies on the effect of OPTEMPO on the retention of medical care givers. The findings of these studies confirmed that military medical care professionals showed a higher rate of retention in the early stage of the GWOT (Pierre, 2005; Dietrich, 2007). The increased OPTEMPO, however, had a negative effect on retention in the Medical Corps, especially after the Iraq War (Bristol, 2006). Therefore, we evaluate the effect of the protracted GWOT before and after October 1, 2004. This point in time is chosen because, first, it has been three years since the war against terror was declared and almost 18 months after the initiation of the Iraq War. Second, technically, we are not able to observe the retention behavior of Navy Medical Corps personnel before FY2002 due to data limitations. Accordingly, we cannot compare retention before and after the event of 9/11.

The results of the secondary model are presented in Table 12. The *post_2004* variable is found to be statistically significant at a 0.01 level. The prolonged GWOT has a negative effect on the overall retention behavior of unobligated, fully trained specialists.

The retention probability after FY2004 is 14.1 percentage points less than the retention probability during the period from FY2002 through FY2004.

For more analyses, we investigate whether retention patterns vary systematically across specialty groups by the period or not. For this purpose, interactions between *Post_2004* dummy and surgical specialties' group dummy (*Post_2004_Surgical*) and between *Post_2004* dummy and other specialties' group dummy (*Post_2004_OtherSpc*) are incorporated in the secondary model. The *Post_2004* indicator suggests that for the primary care group (the reference specialty group), their retention probability is lower by 14 percentage points after FY2004 compared to the initial period of the GWOT. The positive interaction coefficients between FY2004 and the other specialty groups indicate that surgeons and other specialty physicians have a higher probability of staying in the Navy *relative* to the primary care physicians, even though their overall retention probability post-FY2004 is still lower than the initial period of the GWOT (e.g.,, for surgeons, retention probability post-FY2004 is lower than the pre-FY2004 period by 6.5 percentage point [–0.141+0.076= –0.065]). The differential time trend in retention probability across specialty groups is statistically significant at a level of 0.01.

Furthermore, an interaction between *Post_2004* and *female* dummy variables is also included in the model to observe if the retention behavior of female physicians has changed over time as a result of the prolonged GWOT. The results, however, indicate that the retention of female physicians after FY2004 is statistically indifferent than their retention behavior before FY2004.

Table 12. Secondary Model Results.

| **Variables** | **Secondary Model** | |
|---|---|---|
| | **Probit** | **Marginal Effect** |
| *CivMilGap* | –0.00537*** | –0.00186*** |
| *(in $1000 increment)* | (0.000810) | (0.000279) |
| *Post_2004* | –0.420*** | –0.141*** |
| | (0.0824) | (0.0268) |
| *Post_2004_Surgical* | 0.230** | 0.0760** |
| | (0.115) | (0.0359) |
| *Post_2004_OtherSpc* | 0.338*** | 0.110*** |
| | (0.106) | (0.0323) |
| *Post_2004_female* | 0.127 | 0.0430 |

| Variables | Secondary Model | |
|---|---|---|
| | **Probit** | **Marginal Effect** |
| | (0.0982) | (0.0323) |
| *female* | –0.200** | –0.0706** |
| | (0.0804) | (0.0290) |
| *male* | **Reference Category** | |
| *black* | –0.573*** | –0.216*** |
| | (0.0724) | (0.0285) |
| *asian* | 0.0917 | 0.0310 |
| | (0.102) | (0.0337) |
| *hispanic* | 0.0610 | 0.0208 |
| | (0.138) | (0.0463) |
| *other* | –0.637*** | –0.243*** |
| | (0.104) | (0.0409) |
| *white* | **Reference Category** | |
| *lt* | –0.166 | –0.0595 |
| | (0.145) | (0.0535) |
| *lcdr* | –0.542*** | –0.176*** |
| | (0.0804) | (0.0242) |
| *cpt* | –0.0573 | –0.0200 |
| | (0.103) | (0.0364) |
| *cdr* | **Reference Category** | |
| *YOS* | –0.141*** | –0.0488*** |
| | (0.0229) | (0.00791) |
| $YOS^2$ | 0.00220*** | 0.000760*** |
| | (0.000715) | (0.000247) |
| *age* | –0.205*** | –0.0709*** |
| | (0.0578) | (0.0200) |
| $age^2$ | 0.00243*** | 0.000842*** |
| | (0.000692) | (0.000239) |
| *USUHS* | 0.160** | 0.0534** |
| | (0.0643) | (0.0208) |
| *AFHPSP_DEF* | –0.474*** | –0.173*** |
| | (0.0700) | (0.0264) |
| *FAP* | –0.561*** | –0.214*** |
| | (0.201) | (0.0800) |
| *AFHPSP* | **Reference Category** | |
| *GenSurg* | –0.0281 | –0.00978 |
| | (0.148) | (0.0519) |
| *NeuroSurg* | 1.249*** | 0.261*** |
| | (0.338) | (0.0286) |
| *OBGYN* | –0.294** | –0.107* |
| | (0.144) | (0.0552) |
| *Ophthal* | 0.00136 | 0.000471 |
| | (0.182) | (0.0630) |
| *OrthoSurg* | 0.590*** | 0.171*** |
| | (0.147) | (0.0337) |
| *Otolary* | 0.126 | 0.0420 |
| | (0.169) | (0.0544) |

| Variables | Secondary Model | |
|---|---|---|
| | Probit | Marginal Effect |
| *Urology* | 0.00977 | 0.00337 |
| | (0.177) | (0.0611) |
| *OccupMedicine* | –0.0828 | –0.0292 |
| | (0.197) | (0.0707) |
| *PhyRehab* | –0.172 | –0.0619 |
| | (0.338) | (0.126) |
| *Pathology* | 0.336** | 0.105** |
| | (0.148) | (0.0411) |
| *Dermatology* | 0.137 | 0.0455 |
| | (0.135) | (0.0432) |
| *EmergencyMedicine* | –0.241** | –0.0871* |
| | (0.121) | (0.0454) |
| *FamilyPrac* | –0.477*** | –0.175*** |
| | (0.148) | (0.0563) |
| *InternalMedicine* | –0.561*** | –0.212*** |
| | (0.160) | (0.0631) |
| *Neurology* | –0.544** | –0.207** |
| | (0.228) | (0.0907) |
| *Pediatrics* | –0.569*** | –0.214*** |
| | (0.161) | (0.0633) |
| *Psychiatry* | –0.697*** | –0.266*** |
| | (0.159) | (0.0624) |
| *DiagRadiology* | 0.522*** | 0.155*** |
| | (0.128) | (0.0311) |
| *Anesth* | **Reference Category** | |
| *Constant* | 7.345*** | |
| | (1.143) | |
| Observations | 4,478 | 4,478 |
| Standard errors in parentheses<br>*** p<0.01, ** p<0.05, * p<0.1 | | |

## I. SENSITIVITY ANALYSES

Compensations are incorporated in the regression models utilized in this study at their medians, rather than their mean, in order to control for the outliner effect. For sensitivity analyses, a separate regression model is constructed using the mean of the civilian compensations to observe whether the effect of the pay gap on retention differs significantly than that of the main model or not. Table 13 presents the results of a retention probit model using the civilian compensations' mean.

By incorporating the mean of civilian compensations rather than their median, the average of the pay deferential is increased from $98,787.4 to $115,522. The effect of the civilian-military pay gap on the retention of the average physician increases slightly from

(–0.00161) to (–0.00169) for each additional $1,000 increase in the pay gap. This is still significant at a 0.01 level. With regard to the impact on the total retention probability, it appears that for each $1,000 increase in the pay gap the retention probability reduces by 0.25% instead of 0.24% in the main model. The statistical significance of other explanatory variables has not changed when using the civilian compensations' mean, while the difference between their marginal effects in the main model and the model uses the mean of the civilian compensations is found to be practically insignificant.

Military members have a tax advantage due to the nontaxable nature of their BAH and BAS. The analyses conducted in this study, however, do not take these tax advantages into account when calculating the military pays for two reasons: first, civilian compensations are measured before taxes. Second, military tax advantages are considered to be benefits, rather than pay. Accordingly, it is more appropriate to not include the tax advantages in the military pay calculations. Nevertheless, a supplementary probit model is constructed using military pays that include BAH and BAS tax advantages in order to observe if the pay gap's effect on retention differs than that of the main model.[11] Table 13 shows the results of the retention model that incorporates military pay with tax advantages. The average civilian-military pay gap is reduced from $98,787.4 to $93,666.2 by including the tax advantages. The results in Table 13 indicate that the effect of the civilian-military pay gap on retention is exactly the same whether we include the tax advantages in the military pay or not. Similarly, with regard to the effect of other explanatory variables, they are practically indifferent than their results in the main model, while maintaining the same levels of statistical significance.

Table 13. Results of Sensitivity Analysis Models.

| **Variables** | **Retention Model with Civilian Compensations' Mean** | | **Retention Model with Tax Advantages** | |
|---|---|---|---|---|
| | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** |
| *CivMilGap* | –0.00489*** | –0.00169*** | –0.00466*** | –0.00161*** |
| *(in $1000 increment)* | (0.000746) | (0.000256) | (0.000797) | (0.000274) |
| *female* | –0.117** | –0.0410** | –0.117** | –0.0408** |

[11] According to Bureau of Labor Statistics, the average American tax rate is 25%. Therefore, this rate is implemented in our analysis for physicians with dependents, filing jointly.

| Variables | Retention Model with Civilian Compensations' Mean | | Retention Model with Tax Advantages | |
|---|---|---|---|---|
| | Probit | Marginal Effect | Probit | Marginal Effect |
| | (0.0512) | (0.0181) | (0.0511) | (0.0181) |
| *male* | **Reference Category** | | | |
| *black* | –0.598*** | –0.226*** | –0.601*** | –0.227*** |
| | (0.0763) | (0.0300) | (0.0763) | (0.0299) |
| *asian* | 0.100 | 0.0337 | 0.0994 | 0.0335 |
| | (0.103) | (0.0336) | (0.103) | (0.0337) |
| *hispanic* | 0.0400 | 0.0137 | 0.0477 | 0.0163 |
| | (0.139) | (0.0469) | (0.139) | (0.0467) |
| *other* | –0.594*** | –0.226*** | –0.590*** | –0.224*** |
| | (0.104) | (0.0413) | (0.104) | (0.0413) |
| *white* | **Reference Category** | | | |
| *lt* | –0.179 | –0.0640 | –0.174 | –0.0622 |
| | (0.145) | (0.0538) | (0.145) | (0.0538) |
| *lcdr* | –0.546*** | –0.177*** | –0.544*** | –0.176*** |
| | (0.0805) | (0.0241) | (0.0805) | (0.0242) |
| *cpt* | –0.0730 | –0.0256 | –0.0682 | –0.0239 |
| | (0.103) | (0.0364) | (0.103) | (0.0365) |
| *cdr* | **Reference Category** | | | |
| *YOS* | –0.129*** | –0.0445*** | –0.136*** | –0.0469*** |
| | (0.0230) | (0.00792) | (0.0229) | (0.00791) |
| $YOS^2$ | 0.00190*** | 0.000655*** | 0.00207*** | 0.000716*** |
| | (0.000717) | (0.000247) | (0.000716) | (0.000247) |
| *age* | –0.213*** | –0.0734*** | –0.219*** | –0.0756*** |
| | (0.0580) | (0.0200) | (0.0579) | (0.0200) |
| $age^2$ | 0.00252*** | 0.000870*** | 0.00259*** | 0.000894*** |
| | (0.000695) | (0.000239) | (0.000694) | (0.000240) |
| *USUHS* | 0.151** | 0.0505** | 0.142** | 0.0478** |
| | (0.0650) | (0.0210) | (0.0649) | (0.0211) |
| *AFHPSP_DEF* | –0.460*** | –0.167*** | –0.490*** | –0.179*** |
| | (0.0709) | (0.0267) | (0.0702) | (0.0265) |
| *FAP* | –0.450** | –0.169** | –0.480** | –0.182** |
| | (0.202) | (0.0801) | (0.202) | (0.0804) |
| *AFHPSP* | **Reference Category** | | | |
| *GenSurg* | –0.0320 | –0.0111 | –0.0711 | –0.0250 |
| | (0.122) | (0.0429) | (0.125) | (0.0447) |
| *NeuroSurg* | 1.269*** | 0.262*** | 0.974*** | 0.232*** |
| | (0.343) | (0.0278) | (0.327) | (0.0425) |
| *OBGYN* | –0.260** | –0.0943** | –0.307** | –0.112** |
| | (0.117) | (0.0443) | (0.124) | (0.0475) |
| *Ophthal* | 0.0602 | 0.0204 | –0.0463 | –0.0162 |
| | (0.163) | (0.0544) | (0.165) | (0.0583) |
| *OrthoSurg* | 0.666*** | 0.187*** | 0.455*** | 0.138*** |
| | (0.143) | (0.0301) | (0.128) | (0.0327) |
| *Otolary* | 0.226 | 0.0731 | 0.0633 | 0.0215 |
| | (0.153) | (0.0459) | (0.153) | (0.0512) |
| *Urology* | 0.0367 | 0.0125 | –0.0680 | –0.0239 |
| | (0.164) | (0.0555) | (0.164) | (0.0584) |

| Variables | Retention Model with Civilian Compensations' Mean | | Retention Model with Tax Advantages | |
|---|---|---|---|---|
| | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** |
| *OccupMedicine* | –0.236 | –0.0859 | –0.221 | –0.0801 |
| | (0.186) | (0.0707) | (0.192) | (0.0724) |
| *PhyRehab* | 0.0612 | 0.0207 | –0.0969 | –0.0343 |
| | (0.337) | (0.112) | (0.342) | (0.124) |
| *Pathology* | 0.502*** | 0.148*** | 0.339** | 0.106*** |
| | (0.148) | (0.0353) | (0.148) | (0.0410) |
| *Dermatology* | 0.343** | 0.107*** | 0.130 | 0.0435 |
| | (0.141) | (0.0388) | (0.136) | (0.0436) |
| *EmergencyMedicine* | –0.212* | –0.0762* | –0.204* | –0.0735 |
| | (0.117) | (0.0437) | (0.121) | (0.0450) |
| *FamilyPrac* | –0.630*** | –0.233*** | –0.613*** | –0.226*** |
| | (0.135) | (0.0515) | (0.143) | (0.0545) |
| *InternalMedicine* | –0.702*** | –0.267*** | –0.685*** | –0.261*** |
| | (0.148) | (0.0581) | (0.155) | (0.0606) |
| *Neurology* | –0.404* | –0.151* | –0.473** | –0.179** |
| | (0.222) | (0.0876) | (0.228) | (0.0907) |
| *Pediatrics* | –0.694*** | –0.263*** | –0.684*** | –0.260*** |
| | (0.149) | (0.0583) | (0.157) | (0.0614) |
| *Psychiatry* | –0.607*** | –0.231*** | –0.590*** | –0.224*** |
| | (0.153) | (0.0603) | (0.159) | (0.0627) |
| *DiagRadiology* | 0.519*** | 0.154*** | 0.455*** | 0.138*** |
| | (0.130) | (0.0314) | (0.128) | (0.0328) |
| *Anesth* | **Reference Category** | | | |
| *fy03* | 0.149* | 0.0496* | 0.163* | 0.0545* |
| | (0.0902) | (0.0291) | (0.0901) | (0.0289) |
| *fy04* | 0.229*** | 0.0751*** | 0.226*** | 0.0744*** |
| | (0.0861) | (0.0267) | (0.0860) | (0.0268) |
| *fy05* | 0.0719 | 0.0244 | 0.0919 | 0.0311 |
| | (0.0855) | (0.0286) | (0.0863) | (0.0286) |
| *fy06* | –0.140 | –0.0496 | –0.138 | –0.0491 |
| | (0.0872) | (0.0317) | (0.0878) | (0.0319) |
| *fy07* | 0.0112 | 0.00385 | 0.0150 | 0.00518 |
| | (0.0922) | (0.0317) | (0.0934) | (0.0320) |
| *fy08* | –0.255*** | –0.0926** | –0.248** | –0.0900** |
| | (0.0956) | (0.0361) | (0.0967) | (0.0365) |
| *fy09* | –0.172* | –0.0617* | –0.182* | –0.0653* |
| | (0.0996) | (0.0368) | (0.0998) | (0.0370) |
| *fy10* | –0.249** | –0.0901** | –0.261*** | –0.0951** |
| | (0.100) | (0.0380) | (0.101) | (0.0382) |
| *fy11* | –0.0756 | –0.0265 | –0.103 | –0.0365 |
| | (0.107) | (0.0382) | (0.107) | (0.0386) |
| *fy02* | **Reference Category** | | | |
| *Constant* | 7.360*** | | 7.451*** | |
| | (1.147) | | (1.145) | |
| Observations | 4,478 | 4,478 | 4,478 | 4,478 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

## J. PROJECTION MODELS RESULTS

Based on the BUMED dataset, there are only 10 records of yearly retention rates (FY2002 through FY2011). With such limited availability of historical data and due to the nature of the time-series smoothing models, the analysis is conducted to extrapolate the expected retention rates for one additional year—to predict the retention rates for FY2012. Four time-series smoothing models are implemented: the mean forecasting model, the three periods moving average forecasting model, the four periods moving average forecasting model, and the exponential smoothing forecasting model. These models are utilized to project the aggregate retention rates, as well as the retention rates for each specialty and specialty group specified in this study. The results of the four models are presented in Appendix B.

### 1. The Overall Accuracy of the Forecasting Models

The accuracy of a forecasting model used in this study is measured based on the forecasting error, which is the deviation between the actual retention rates and the forecasted retention rates. The most common measures of the forecasting error are: Mean Absolut Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percent Error (MAPE). MAD is the average of the absolute errors between the actual values and the forecasted values and is calculated as:

$$MAD=\sum_{t=1}^{n}|A_t-F_t|/T,$$

where: $A_t$ = Actual value for period $t$

$F_t$ = Forecasted value for period $t$

$T$ = The total number of time periods.

MSE is the average of the squared errors between the actual values and the forecasted values and is calculated as:

$$MSE=\sum_{t=1}^{n}(A_t-F_t)^2/T.$$

MAPE is the average of the absolute errors between the actual value and the forecasted value, specified as a percentage of the actual value. MAPE is calculated as:

$$MAPE=100\sum_{t=1}^{n}(\frac{|A_t-F_t|}{A_t})/T.$$

In this study, the goodness of a forecasting model is evaluated based on MAPE, when possible. The reason is that MAPE accounts for the magnitude of values being forecasted, while MAD and MSE are inflated if the values being forecasted are very large.

Table 14 presents the actual and the forecasted retention rates from FY2002 through FY2011, as well as the projected retention rates for FY2012. This is evaluated for the aggregate pool of fully trained, unobligated physicians and for the physicians of each specialty group and each individual specialty. Table 14 indicates which forecasting model is utilized, based on its MAPE, whenever it is applicable.

Table 14. Projection Models Results.

| | | Fiscal Years | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Specialty** | | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
| Overall retention | Actual Rates | 0.74 | 0.73 | 0.79 | 0.73 | 0.62 | 0.65 | 0.55 | 0.60 | 0.53 | 0.58 | |
| | Predicted Rates (1) | | | | 0.75 | 0.75 | 0.71 | 0.67 | 0.61 | 0.60 | 0.56 | 0.57 |
| Primary Care Specialties | Actual Rates | 0.78 | 0.72 | 0.78 | 0.72 | 0.64 | 0.62 | 0.55 | 0.55 | 0.56 | 0.61 | |
| | Predicted Rates (1) | | | | 0.76 | 0.74 | 0.71 | 0.66 | 0.60 | 0.58 | 0.55 | 0.57 |
| Family Practice | Actual Rates | 0.79 | 0.74 | 0.79 | 0.68 | 0.60 | 0.63 | 0.54 | 0.59 | 0.50 | 0.64 | |
| | Predicted Rates (1) | | | | 0.78 | 0.74 | 0.69 | 0.64 | 0.59 | 0.59 | 0.54 | 0.58 |
| Internal Medicine | Actual Rates | 0.79 | 0.57 | 0.81 | 0.82 | 0.69 | 0.54 | 0.60 | 0.50 | 0.61 | 0.53 | |
| | Predicted Rates (1) | | | | 0.72 | 0.73 | 0.77 | 0.68 | 0.61 | 0.55 | 0.57 | 0.55 |
| Pediatrics | Actual Rates | 0.71 | 0.77 | 0.76 | 0.76 | 0.70 | 0.68 | 0.55 | 0.46 | 0.67 | 0.63 | |
| | Predicted Rates (3) | 0.71 | 0.71 | 0.73 | 0.74 | 0.75 | 0.73 | 0.72 | 0.67 | 0.61 | 0.62 | 0.62 |
| Occupational Medicine | Actual Rates | 1.00 | 0.69 | 0.67 | 0.89 | 0.64 | 0.58 | 0.55 | 0.75 | 0.57 | 0.60 | |
| | Predicted Rates (1) | | | | 0.79 | 0.75 | 0.73 | 0.71 | 0.59 | 0.63 | 0.62 | 0.64 |
| Surgical Specialties | Actual Rates | 0.75 | 0.73 | 0.79 | 0.74 | 0.57 | 0.69 | 0.57 | 0.63 | 0.49 | 0.48 | |
| | Predicted Rates (3) | 0.75 | 0.75 | 0.75 | 0.76 | 0.75 | 0.70 | 0.69 | 0.66 | 0.65 | 0.60 | 0.57 |
| General Surgery | Actual Rates | 0.88 | 0.79 | 0.88 | 0.68 | 0.54 | 0.67 | 0.60 | 0.76 | 0.41 | 0.54 | |
| | Predicted Rates (3) | 0.88 | 0.88 | 0.86 | 0.86 | 0.81 | 0.73 | 0.71 | 0.68 | 0.70 | 0.62 | 0.59 |
| Neurological Surgery | Actual Rates | 0.67 | 0.80 | 0.50 | 0.00 | 1.00 | 0.50 | 0.67 | 0.00 | 1.00 | 0.50 | |
| | Predicted Rates (2) * | | | | | 0.49 | 0.58 | 0.50 | 0.54 | 0.54 | 0.54 | 0.54 |
| Orthopedic Surgery | Actual Rates | 0.81 | 0.67 | 0.82 | 0.59 | 0.67 | 0.68 | 0.46 | 0.47 | 0.64 | 0.46 | |
| | Predicted Rates (1) | | | | 0.77 | 0.69 | 0.69 | 0.64 | 0.60 | 0.54 | 0.52 | 0.52 |
| OB/GYN | Actual Rates | 0.61 | 0.55 | 0.73 | 0.88 | 0.57 | 0.70 | 0.67 | 0.71 | 0.52 | 0.63 | |
| | Predicted Rates (2) | | | | | 0.69 | 0.68 | 0.72 | 0.70 | 0.66 | 0.65 | 0.63 |
| Ophthalmology | Actual Rates | 0.75 | 0.85 | 0.92 | 0.70 | 0.45 | 0.67 | 0.71 | 0.71 | 0.50 | 0.00 | |
| | Predicted Rates (3) * | 0.75 | 0.75 | 0.78 | 0.82 | 0.79 | 0.69 | 0.68 | 0.69 | 0.70 | 0.64 | 0.45 |
| Otolaryngology | Actual Rates | 0.85 | 0.85 | 0.83 | 0.86 | 0.78 | 0.60 | 0.29 | 0.67 | 0.50 | 0.14 | |
| | Predicted Rates (3) | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.83 | 0.76 | 0.62 | 0.63 | 0.59 | 0.46 |

| | | Fiscal Years | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Specialty** | | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
| Urology | Actual Rates | 0.69 | 0.94 | 0.65 | 0.71 | 0.20 | 1.00 | 0.83 | 0.50 | 0.17 | 0.67 | |
| | Predicted Rates (4) | 0.69 | 0.69 | 0.77 | 0.73 | 0.73 | 0.57 | 0.70 | 0.74 | 0.67 | 0.52 | 0.56 |
| Other Specialties | Actual Rates | 0.69 | 0.73 | 0.80 | 0.73 | 0.63 | 0.66 | 0.53 | 0.62 | 0.54 | 0.60 | |
| | Predicted Rates (3) | 0.69 | 0.69 | 0.70 | 0.73 | 0.73 | 0.70 | 0.69 | 0.64 | 0.64 | 0.61 | 0.61 |
| Anesthesiology | Actual Rates | 0.51 | 0.68 | 0.82 | 0.67 | 0.67 | 0.63 | 0.54 | 0.62 | 0.55 | 0.58 | |
| | Predicted Rates (1) | | | | 0.67 | 0.72 | 0.72 | 0.65 | 0.61 | 0.59 | 0.57 | 0.58 |
| Dermatology | Actual Rates | 0.70 | 0.68 | 0.94 | 0.78 | 0.47 | 0.71 | 0.50 | 0.56 | 0.43 | 0.88 | |
| | Predicted Rates (3) | 0.70 | 0.70 | 0.69 | 0.77 | 0.77 | 0.68 | 0.69 | 0.63 | 0.61 | 0.55 | 0.65 |
| Emergency Medicine | Actual Rates | 0.87 | 0.77 | 0.76 | 0.70 | 0.66 | 0.59 | 0.56 | 0.64 | 0.60 | 0.64 | |
| | Predicted Rates(1) | | | | 0.80 | 0.74 | 0.71 | 0.65 | 0.60 | 0.59 | 0.60 | 0.63 |
| Neurology | Actual Rates | 0.71 | 0.20 | 1.00 | 0.83 | 0.50 | 1.00 | 0.33 | 0.50 | 0.75 | 0.50 | |
| | Predicted Rates (1) | | | | 0.64 | 0.68 | 0.78 | 0.78 | 0.61 | 0.61 | 0.53 | 0.58 |
| Pathology | Actual Rates | 0.76 | 0.64 | 0.72 | 0.67 | 0.63 | 0.89 | 0.70 | 0.89 | 0.44 | 1.00 | |
| | Predicted Rates (4) | | 0.76 | 0.70 | 0.71 | 0.70 | 0.68 | 0.72 | 0.72 | 0.74 | 0.70 | 0.73 |
| Physical and Rehabilitation | Actual Rates | Not enough observations to conduct the analysis | | | | | | | | | | |
| | Predicted Rates | | | | | | | | | | | |
| Psychiatry | Actual Rates | 0.50 | 0.89 | 0.64 | 0.78 | 0.69 | 0.43 | 0.83 | 0.55 | 0.53 | 0.56 | |
| | Predicted Rates (1) | | | | 0.68 | 0.77 | 0.71 | 0.63 | 0.65 | 0.60 | 0.64 | 0.54 |
| Radiology | Actual Rates | 0.63 | 0.76 | 0.89 | 0.78 | 0.62 | 0.87 | 0.26 | 0.62 | 0.53 | 0.36 | |
| | Predicted Rates (3) | 0.63 | 0.63 | 0.67 | 0.73 | 0.75 | 0.71 | 0.76 | 0.61 | 0.61 | 0.59 | 0.52 |

(1) Three periods Moving Average Forecasting
(2) Four periods Moving Average Forecasting
(3) Exponential Smoothing Forecasting
(4) Mean Forecasting
(*) MSE used instead of MAPE since one or more actual observations equals zero.

Figure 3 illustrates the actual retention rates for the aggregate pool of fully trained, unobligated Navy physicians from FY2002 through FY2011 as well as the predicated retention rates from FY2002 through FY2012 using the three periods moving average forecasting model. Figure 3 also displays the upper and lower bounds of a 90% Confidence Interval (CI) for FY2012 prediction.

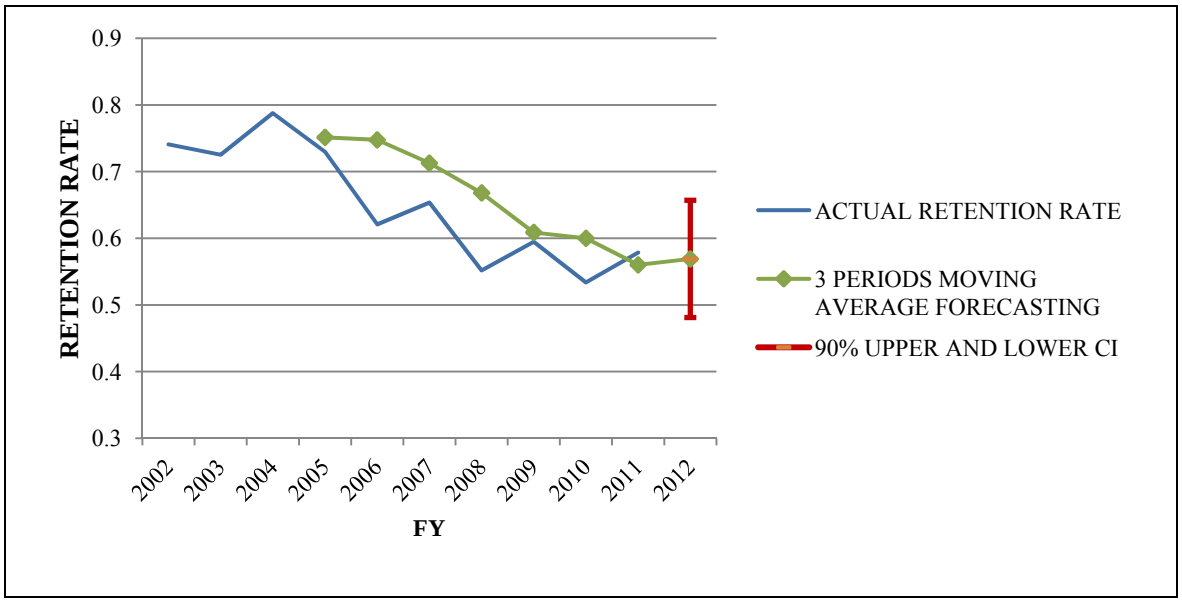


Figure 3. Actual Retention Rates vs. Predicted Retention Rates

According to the projection models, the aggregate retention probability for FY2012 is expected to be 57%, which is one percentage point lower than the actual retention rate of FY2011 (58%) with a 90% upper CI of (66% ) and a lower CI of ( 48%). The expected reduction in the overall retention probability is driven by a forecasted reduced of four percentage points in the retention rate of primary care specialists in FY2012.

On the other hand, the surgical specialties group is expected to demonstrate an increase in the retention rate by 9 percentage points in FY2012 compared to that of FY2011. Similarly, the other specialties group retention rate in FY2012 is expected to be one percentage point higher than that of FY2011.

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# VI. CONCLUSIONS AND RECOMMENDATIONS

## A. CONCLUSIONS

This study examines the effect that the civilian-military pay gap has on the retention of Navy doctors across 19 specialties for the years between FY2002 and FY2011. The probit results suggest that the civilian-military pay gap does, in fact, affect the retention of unobligated Navy medical specialists. As the civilian-military pay gap increases, it becomes more difficult to retain doctors in the Navy when their skills are easily transferable into the civilian sector. Retaining unobligated Navy medical specialists is an important planning and business process, and is critical to the Navy in maintaining the desired manning of skilled and experienced medical personnel. Having accurate plans and policies will help BUMED to better assess its manning projections among the various Medical Corps specialties, and it will also assist in setting adequate special and incentive pay rates to maintain its manning requirements.

In general, our study finds that, on average, there is a pay gap of $98,787 between a civilian and a military provider, and 67% of Navy physicians stay beyond their initial obligation. When examining individual subspecialties in the Medical Corps, we find that OB/GYN has the highest sensitivity to the pay gap with an elasticity of (–1.42), while pediatrics specialists display the least responsiveness to the pay gap with an elasticity of (–0.19). Furthermore, the analysis suggests that a person's ethnicity has a large impact on that person's propensity to stay in the Navy. For example, Blacks have a 23-percentage point higher probability of leaving the Navy compared to their White counterparts. However, over 75% of our study's sample was considered White; therefore, a small change among the Blacks participants had a greater impact on our results, due to sample size. Finally, we found that the providers who used the USUHS accession source had a higher probability of staying in the Navy relative to providers who used the other accession sources offered by the Navy.

As a robustness check, we include the tax benefits that military personnel receive to determine if the main results change.[12] The results are not sensitive to changes in the civilian-military pay gap that result from tax benefits and find that the effect of the civilian-military pay gap on retention was extremely close.

In addition to examining how the civilian-military pay gap affects retention, we also examine the effect that the protracted GWOT had on the probability of staying in the Medical Corps. Our study finds that the protracted GWOT had a negative effect on the overall retention behavior of unobligated, fully trained specialists. Compared to the start of the GWOT (FY2002 to FY2004), our results suggest that the prolonged GWOT period of FY2005 to FY2011 increased the average probability that a medical specialist would leave the Navy by 14.1 percentage points, with the largest impact felt among the primary care physicians. We further find that while the Navy overall had a higher retention rate compared to 2008 before the recession, the Medical Corps has not been as fortunate in retaining its personnel.

While we recognize that financial compensation is not the only factor considered when providers decide to stay or leave the Navy, we believe that the civilian-military pay gap is a key determinant. Other variables that affect providers' decisions are military lifestyle, military benefits, and OPTEMPO. Unfortunately, one limitation of our study is that we did not have access to these variables: however, it captures a major key aspect that predicts retention behavior and provides evidence that the civilian-military pay gap does affect retention. The Navy will have to reconsider its current financial compensation program and weigh the costs and benefits, if they want to increase the retention rate of these professionals.

## B. RECOMMENDATIONS

As the civilian-military pay gap increases, it becomes more difficult to retain doctors in the Navy when their skills are easily transferable into the civilian sector. As a result, the Navy will potentially always have issues retaining its medical providers. The inherent nature of the military pay structure means that providers will not get

[12] The pay gap was reduced from $98,787 to $93,666 when the tax benefit was included in our model.

compensated as well as their counterparts in the civilian sector. However, in order to maintain or increase its retention rate of medical providers, we recommend that the Navy consider the following:

- Continue to strengthen its current accession sources for becoming a medical officer in the U.S. Navy, especially the USUHS program. In particular, we recommend that the USUHS program increase its annual quota limits. According to our findings, USUHS students have a 22.7% and 23% higher probability of staying in the Navy, relative to the AFHPSP and FAP, respectively. Therefore, the Navy should increase or shift its funding in support of the USUHS program.
- Increase the MSP amount and offer the MSP earlier, rather than waiting until the providers come to their initial decision to stay in or leave the Navy. In our study, we find that LCDRs have a 17.7% greater chance of attrition than CDRs, who have been in the Navy longer. Therefore, offer the MSP earlier to the LTs and LCDRs before the provider's initial obligation of service is over. Also, increase the MSP amount given to these officers. With a $10,000 annual increase in the primary care category, the Navy could potentially increase retention by 11%. The increase in the MSP amount could be used to target these junior Medical Corps officers and reduce the civilian-military pay gap, which would, in turn, increase the probability that they would stay in the Navy.
- Increase MSP to the primary care and surgical specialty category relative to the other specialty group. This will have a larger impact on retention, respectively, than in the other specialty category because the average civilian-military pay gap in the other specialties category is $134,886, compared to the pay gap for a primary care specialist, which is only $26,490. With current DoD budget issues, the Navy will be financially unable to reduce the pay gap in the other specialties category. For example, if the Navy reduced the other specialties civilian-military pay gap to zero, it will increase the provider retention rate from 67% to 79.7%,

a difference of only 12.7%; whereas, if the Navy used the money saved from to retaining other specialties in primary care service, the Navy would get a better return on its investment. Therefore, the Navy should increase residency personnel quotas and increase their obligations of service when they finish their residency. With the additional money saved, the Navy could pay for the referrals of patients who need these specific services and/or use the savings to offset the increase in TRICARE premium. Furthermore, the Navy could staff the Military Treatment Facilities (MTFs) with senior civilian providers and with junior providers who have just graduated from school.

These recommendations many not solve the retention problems in the Medical Corps; however, these proposals provide some alternatives that the Navy could implement to reduce the civilian-military pay gap.

## C. FURTHER RESEARCH

Previous findings show that basic pay, job security, retirement pay, job enjoyment, and family medical care were the top five factors that encouraged individuals to stay in the military. On the other hand, basic pay, amount of personal and family time, quality of leadership, job enjoyment, and deployment were the top five factors for leaving the military (Weiss et al., 2003). In our study, we only looked at how the civilian-military pay gap has affected retention of doctors in the Medical Corps. One limitation of our study is that we did not have access to data on marital status, dependents, degree of patriotism, number of deployments, amount of personal and family time, etc. Future research should use these variables in the analysis. However, we do discuss how basic demographics, such as gender and race, affect retention rates. Additional research should further inspect why the Blacks population had a higher propensity for attrition, and why there has not been a significant increase in the number of female medical providers in the last 10 years.

This study looked at the tax advantage that the Navy providers received and tested how that would affect retention; however, we did not include the huge benefit for medical

providers in the Navy, which is that Navy providers do not have to carry malpractice insurance. Depending on the specialty of these providers, this can have an immense impact on the civilian-military pay gap. We recommend that in the future, researchers replicate our initial study and factor in the effect of malpractice insurance on the civilian-military pay gap, which would give a more realistic picture of the civilian-military pay differential.

Finally, we recommend that future research involve a cost-benefit analysis (CBA) regarding our recommendations. The research could focus on the cost of implementing our recommendations and, if these recommendations are implemented, how much money it could save/cost the Navy. Furthermore, researchers should examine how the quality of care given by medical providers has changed due to changes in the pay gap.

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# APPENDIX A. INCENTIVE SPECIAL PAY (ISP) AND MULTIYEAR SPECIAL PAY (MSP) TABLE

| | FY02 | | FY03 | | FY04 | | FYO5 | | FY06 | | FY07 | | FY08 | | FY09 | | FY10 | | FY11 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Specialty:** | ISP | ISP w/MSP | ISP | ISP w/MSP | ISP | ISP w/MSP | ISP | ISP w/MSP | ISP | ISP w/MSP | ISP | ISP w/MSP | ISP | ISP w/MSP | ISP | ISP w/MSP | ISP | ISP w/MSP | ISP | ISP w/MSP |
| Aerospace Med | $12,000 | $8,000 | $13,000 | $12,000 | $12,000 | $12,000 | $12,000 | $12,000 | $13,000 | $13,000 | $13,000 | $13,000 | $13,000 | $13,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 |
| Anesthesiology | $36,000 | $12,000 | $36,000 | $12,000 | $36,000 | $36,000 | $36,000 | $36,000 | $36,000 | $42,000 | $36,000 | $42,000 | $36,000 | $50,000 | $36,000 | $50,000 | $36,000 | $50,000 | $36,000 | $50,000 |
| Cardiology-Adult | $36,000 | $12,000 | $36,000 | $12,000 | $36,000 | $36,000 | $36,000 | $36,000 | $36,000 | $41,000 | $36,000 | $41,000 | $36,000 | $41,000 | $36,000 | $41,000 | $36,000 | $41,000 | $36,000 | $41,000 |
| Dermatology | $18,000 | $8,000 | $18,000 | $12,000 | $18,000 | $18,000 | $18,000 | $18,000 | $18,000 | $18,000 | $18,000 | $18,000 | $18,000 | $18,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 |
| Emergency Medicine | $26,000 | $8,000 | $26,000 | $12,000 | $26,000 | $26,000 | $26,000 | $26,000 | $26,000 | $26,000 | $26,000 | $26,000 | $26,000 | $26,000 | $26,000 | $30,000 | $26,000 | $30,000 | $26,000 | $30,000 |
| Family Practice | $13,000 | $12,000 | $13,000 | $12,000 | $13,000 | $13,000 | $13,000 | $13,000 | $13,000 | $13,000 | $13,000 | $13,000 | $13,000 | $13,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 |
| Gastroenterology | $23,000 | $8,000 | $26,000 | $12,000 | $26,000 | $23,000 | $26,000 | $23,000 | $26,000 | $29,000 | $26,000 | $29,000 | $26,000 | $29,000 | $26,000 | $29,000 | $26,000 | $29,000 | $26,000 | $29,000 |
| General Surgery | $29,000 | $12,000 | $29,000 | $12,000 | $29,000 | $29,000 | $29,000 | $29,000 | $29,000 | $34,000 | $29,000 | $34,000 | $29,000 | $34,000 | $29,000 | $50,000 | $29,000 | $50,000 | $29,000 | $50,000 |
| Internal Medicine | $14,000 | $8,000 | $14,000 | $12,000 | $14,000 | $14,000 | $14,000 | $14,000 | $14,000 | $14,000 | $14,000 | $14,000 | $14,000 | $14,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 |
| Neurology | $14,000 | $8,000 | $14,000 | $12,000 | $14,000 | $14,000 | $14,000 | $14,000 | $14,000 | $14,000 | $14,000 | $14,000 | $14,000 | $14,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 |
| Neurosurgery | $36,000 | $12,000 | $36,000 | $12,000 | $36,000 | $36,000 | $36,000 | $36,000 | $36,000 | $41,000 | $36,000 | $50,000 | $36,000 | $50,000 | $36,000 | $60,000 | $36,000 | $60,000 | $36,000 | $60,000 |
| OB/GYN | $31,000 | $8,000 | $31,000 | $12,000 | $31,000 | $31,000 | $31,000 | $31,000 | $31,000 | $31,000 | $31,000 | $31,000 | $31,000 | $31,000 | $31,000 | $31,000 | $31,000 | $31,000 | $31,000 | $31,000 |
| Ophthalmology | $28,000 | $8,000 | $28,000 | $12,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $30,000 | $28,000 | $30,000 | $28,000 | $30,000 |
| Orthopedics | $36,000 | $12,000 | $36,000 | $12,000 | $36,000 | $36,000 | $36,000 | $36,000 | $36,000 | $41,000 | $36,000 | $41,000 | $36,000 | $41,000 | $36,000 | $50,000 | $36,000 | $50,000 | $36,000 | $50,000 |
| Otolaryngology | $30,000 | $8,000 | $30,000 | $12,000 | $30,000 | $30,000 | $30,000 | $30,000 | $30,000 | $33,000 | $30,000 | $33,000 | $30,000 | $33,000 | $30,000 | $35,000 | $30,000 | $35,000 | $30,000 | $35,000 |
| Pathology | $16,000 | $8,000 | $16,000 | $12,000 | $16,000 | $16,000 | $16,000 | $16,000 | $16,000 | $19,000 | $16,000 | $19,000 | $16,000 | $19,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 |
| Pediatrics | $12,000 | $8,000 | $12,000 | $12,000 | $12,000 | $12,000 | $12,000 | $12,000 | $12,000 | $12,000 | $12,000 | $12,000 | $13,000 | $13,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 |
| Phys Med | $12,000 | $8,000 | $13,000 | $12,000 | $12,000 | $12,000 | $12,000 | $12,000 | $13,000 | $13,000 | $13,000 | $13,000 | $13,000 | $13,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 |
| Prev/Occ Med | $12,000 | $8,000 | $13,000 | $12,000 | $12,000 | $12,000 | $12,000 | $12,000 | $13,000 | $13,000 | $13,000 | $13,000 | $13,000 | $13,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 |
| Psychiatry | $15,000 | $12,000 | $15,000 | $12,000 | $15,000 | $15,000 | $15,000 | $15,000 | $15,000 | $15,000 | $15,000 | $15,000 | $15,000 | $15,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 | $20,000 |
| Pulmonary/ Critical Care | $23,000 | $8,000 | $23,000 | $12,000 | $23,000 | $23,000 | $23,000 | $23,000 | $23,000 | $26,000 | $23,000 | $26,000 | $23,000 | $26,000 | $23,000 | $26,000 | $23,000 | $26,000 | $23,000 | $26,000 |
| Radiology | $36,000 | $12,000 | $36,000 | $12,000 | $36,000 | $36,000 | $36,000 | $36,000 | $36,000 | $42,000 | $36,000 | $42,000 | $36,000 | $42,000 | $36,000 | $42,000 | $36,000 | $42,000 | $36,000 | $42,000 |
| Urology | $28,000 | $8,000 | $28,000 | $12,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 | $28,000 |

Source: Historical Data received from Director, Navy Medical Special Pays Program Chief, Bureau of Medicine and Surgery (M13)

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# APPENDIX B. SPECIALTIES-SPECIFIC MODELS

| Variables | Anesthesiology | | General Surgery | | OB/GYN | |
|---|---|---|---|---|---|---|
| | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** |
| *CivMilGap* | –0.00530** | –0.00198** | –0.0147** | –0.00423** | –0.0318*** | –0.0110*** |
| | (0.00245) | (0.000912) | (0.00676) | (0.00184) | (0.00524) | (0.00175) |
| *female* | –0.0575 | –0.0216 | –0.0280 | –0.00810 | 0.138 | 0.0482 |
| | (0.210) | (0.0796) | (0.276) | (0.0805) | (0.160) | (0.0566) |
| *male* | **Reference Category** | | | | | |
| *minority* | –0.524*** | –0.202*** | –0.586** | –0.191** | 0.0908 | 0.0311 |
| | (0.171) | (0.0663) | (0.255) | (0.0898) | (0.175) | (0.0593) |
| *white* | **Reference Category** | | | | | |
| *lt_lcdr* | –0.736** | –0.244*** | –0.269 | –0.0724 | –0.610 | –0.176* |
| | (0.306) | (0.0866) | (0.327) | (0.0820) | (0.396) | (0.0906) |
| *cdr_cpt* | **Reference Category** | | | | | |
| *YOS* | –0.112** | –0.0418** | –0.0269 | –0.00773 | –0.0173 | –0.00600 |
| | (0.0559) | (0.0208) | (0.0389) | (0.0111) | (0.0297) | (0.0103) |
| $YOS^2$ | 0.00150 | 0.000559 | Omitted since *YOS* & $YOS^2$ are not jointly significant | | | |
| | (0.00201) | (0.000751) | | | | |
| *age* | 0.00416 | 0.00155 | –0.530** | –0.152*** | –0.0169 | –0.00585 |
| | (0.0228) | (0.00852) | (0.214) | (0.0582) | (0.0263) | (0.00910) |
| $age^2$ | Omitted since *age* & $age^2$ are not jointly significant | | 0.00528** | 0.00152** | Omitted since *age* & $age^2$ are not jointly significant | |
| | | | (0.00242) | (0.000663) | | |
| *None_AFHPSP* | –0.0429 | –0.0160 | –0.287 | –0.0806 | 0.150 | 0.0514 |
| | (0.160) | (0.0598) | (0.293) | (0.0792) | (0.199) | (0.0671) |
| *AFHPSP* | **Reference Category** | | | | | |
| *Post_2004* | 0.00557 | 0.00208 | –0.301 | –0.0838 | 0.432** | 0.152** |
| | (0.191) | (0.0714) | (0.284) | (0.0766) | (0.182) | (0.0643) |
| *Prior_2004* | **Reference Category** | | | | | |
| Constant | 2.790*** | | 15.99*** | | 4.155*** | |
| | (0.923) | | (4.808) | | (1.037) | |
| Observations | 368 | 368 | 219 | 219 | 349 | 349 |
| Standard errors in parentheses<br>*** p<0.01, ** p<0.05, * p<0.1 | | | | | | |

| Variables | Opthalmology | | Orthopedic Surgery | | Otolaryngology | |
|---|---|---|---|---|---|---|
| | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** |
| *CivMilGap* | –0.00746 | –0.00243 | –0.00533** | –0.00184** | –0.0180*** | –0.00516*** |
| | (0.00673) | (0.00214) | (0.00235) | (0.000804) | (0.00535) | (0.00148) |
| *female* | 0.270 | 0.0850 | –0.262 | –0.0955 | –0.483 | –0.159 |
| | (0.361) | (0.109) | (0.432) | (0.165) | (0.563) | (0.205) |
| *male* | **Reference Category** | | | | | |
| *minority* | –0.932 | –0.347 | –0.437** | –0.158** | –0.618 | –0.202 |

| Variables | Opthalmology | | Orthopedic Surgery | | Otolaryngology | |
|---|---|---|---|---|---|---|
| | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** |
| | (0.599) | (0.228) | (0.208) | (0.0777) | (0.396) | (0.140) |
| *white* | **Reference Category** | | | | | |
| *lt_lcdr* | –0.815 | –0.262 | –0.508* | –0.159** | –0.371 | –0.107 |
| | (0.698) | (0.215) | (0.279) | (0.0776) | (0.523) | (0.151) |
| *cdr_cpt* | **Reference Category** | | | | | |
| *YOS* | –0.0889 | –0.0290 | –0.0559 | –0.0193 | –0.00302 | –0.000866 |
| | (0.0870) | (0.0283) | (0.0362) | (0.0124) | (0.0614) | (0.0176) |
| $YOS^2$ | Omitted since *YOS* & $YOS^2$ are not jointly significant | | | | | |
| | | | | | | |
| *age* | –0.0320 | –0.0104 | –0.469** | –0.162** | –0.106* | –0.0304* |
| | (0.0683) | (0.0223) | (0.211) | (0.0717) | (0.0607) | (0.0173) |
| $age^2$ | Omitted since *age* & $age^2$ are not jointly significant | | 0.00536** | 0.00185** | Omitted since *age* & $age^2$ are not jointly significant | |
| | | | (0.00250) | (0.000852) | | |
| *None_AFHPSP* | –0.122 | –0.0403 | –0.501** | –0.172** | 0.476 | 0.135 |
| | (0.392) | (0.131) | (0.213) | (0.0716) | (0.347) | (0.0979) |
| *AFHPSP* | **Reference Category** | | | | | |
| *Post_2004* | –0.218 | –0.0701 | –0.0129 | –0.00443 | 0.341 | 0.0980 |
| | (0.408) | (0.129) | (0.262) | (0.0905) | (0.426) | (0.122) |
| *Prior_2004* | **Reference Category** | | | | | |
| *Constant* | 4.782** | | 13.11*** | | 7.604*** | |
| | (2.200) | | (4.356) | | (1.976) | |
| Observations | 96 | 96 | 279 | 279 | 119 | 119 |
| Standard errors in parentheses<br>*** p<0.01, ** p<0.05, * p<0.1 | | | | | | |

| Variables | Pathology | | Dermatology | | Emergency Medicine | |
|---|---|---|---|---|---|---|
| | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** |
| *CivMilGap* | 0.00107 | 0.000348 | –0.00173 | –0.000578 | –0.0135** | –0.00442** |
| | (0.00384) | (0.00125) | (0.00365) | (0.00122) | (0.00640) | (0.00209) |
| *female* | 0.255 | 0.0801 | 0.0462 | 0.0154 | –0.323* | –0.112* |
| | (0.327) | (0.0979) | (0.289) | (0.0952) | (0.177) | (0.0642) |
| *male* | **Reference Category** | | | | | |
| *minority* | –0.930** | –0.340** | –0.221 | –0.0772 | –0.487*** | –0.173*** |
| | (0.362) | (0.136) | (0.344) | (0.125) | (0.178) | (0.0667) |
| *white* | **Reference Category** | | | | | |
| *lt_lcdr* | –0.227 | –0.0732 | –1.234*** | –0.341*** | –0.319 | –0.100 |
| | (0.456) | (0.145) | (0.461) | (0.0997) | (0.233) | (0.0694) |
| *cdr_cpt* | **Reference Category** | | | | | |
| *YOS* | –0.0350 | –0.0115 | –0.328** | –0.110** | –0.00557 | –0.00183 |
| | (0.0581) | (0.0190) | (0.161) | (0.0523) | (0.0306) | (0.0100) |
| $YOS^2$ | Omitted since *YOS* & $YOS^2$ are not jointly | | 0.00858 | 0.00287 | | |
| | | | (0.00595) | (0.00196) | | |

| Variables | Pathology | | Dermatology | | Emergency Medicine | |
|---|---|---|---|---|---|---|
| | Probit | Marginal Effect | Probit | Marginal Effect | Probit | Marginal Effect |
| | significant | | | | | |
| *age* | 0.0207 | 0.00679 | –0.106* | –0.0356* | –0.0620* | –0.0204* |
| | (0.0489) | (0.0160) | (0.0597) | (0.0197) | (0.0327) | (0.0107) |
| $age^2$ | Omitted since *age* & $age^2$ are not jointly significant | | | | | |
| | | | | | | |
| *None_AFHPSP* | –0.312 | –0.106 | 0.107 | 0.0354 | –0.278* | –0.0939 |
| | (0.298) | (0.104) | (0.271) | (0.0889) | (0.165) | (0.0572) |
| *AFHPSP* | **Reference Category** | | | | | |
| *Post_2004* | –0.228 | –0.0744 | 0.0148 | 0.00496 | –0.220 | –0.0716 |
| | (0.325) | (0.105) | (0.365) | (0.122) | (0.207) | (0.0668) |
| *Prior_2004* | **Reference Category** | | | | | |
| *Constant* | 0.557 | | 8.349*** | | 4.819*** | |
| | (1.473) | | (2.614) | | (1.167) | |
| Observations | 119 | 119 | 147 | 147 | 425 | 425 |
| Standard errors in parentheses<br>*** p<0.01, ** p<0.05, * p<0.1 | | | | | | |

| Variables | Family Practice | | Internal Medicine | | Neurology | |
|---|---|---|---|---|---|---|
| | Probit | Marginal Effect | Probit | Marginal Effect | Probit | Marginal Effect |
| *CivMilGap* | –0.0273*** | –0.00959*** | –0.0321*** | –0.0112*** | 0.0189 | 0.00698 |
| | (0.00453) | (0.00158) | (0.00865) | (0.00300) | (0.0205) | (0.00758) |
| *female* | –0.129 | –0.0460 | –0.182 | –0.0642 | 0.240 | 0.0841 |
| | (0.104) | (0.0374) | (0.177) | (0.0633) | (1.077) | (0.357) |
| *male* | **Reference Category** | | | | | |
| *minority* | –0.403*** | –0.149*** | –0.328* | –0.118* | –1.586** | –0.570*** |
| | (0.112) | (0.0426) | (0.187) | (0.0688) | (0.783) | (0.219) |
| *white* | **Reference Category** | | | | | |
| *lt_lcdr* | –0.271 | –0.0912 | –1.251*** | –0.300*** | –2.987** | –0.769*** |
| | (0.200) | (0.0641) | (0.484) | (0.0679) | (1.335) | (0.187) |
| *cdr_cpt* | **Reference Category** | | | | | |
| *YOS* | –0.0425 | –0.0149 | –0.241*** | –0.0838*** | –0.400* | –0.147* |
| | (0.0364) | (0.0128) | (0.0727) | (0.0251) | (0.213) | (0.0790) |
| $YOS^2$ | –0.000959 | –0.000337 | 0.00402* | 0.00140* | 0.00659 | 0.00243 |
| | (0.00112) | (0.000395) | (0.00220) | (0.000764) | (0.00595) | (0.00219) |
| *age* | 0.00970 | 0.00341 | –0.00198 | –0.000689 | –0.0797 | –0.0293 |
| | (0.0158) | (0.00556) | (0.0253) | (0.00878) | (0.0834) | (0.0306) |
| $age^2$ | Omitted since *age* & $age^2$ are not jointly significant | | | | | |
| | | | | | | |
| *None_AFHPSP* | 0.0681 | 0.0238 | 0.244 | 0.0824 | –2.005** | –0.684*** |
| | (0.113) | (0.0392) | (0.266) | (0.0870) | (0.871) | (0.211) |
| *AFHPSP* | **Reference Category** | | | | | |
| *Post_2004* | –0.426*** | –0.145*** | 0.0385 | 0.0134 | –0.346 | –0.125 |
| | (0.100) | (0.0325) | (0.203) | (0.0707) | (0.763) | (0.266) |

| Variables | Family Practice | | Internal Medicine | | Neurology | |
|---|---|---|---|---|---|---|
| | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** |
| *Prior_2004* | **Reference Category** | | | | | |
| *Constant* | 2.020*** | | 4.400*** | | 9.361** | |
| | (0.601) | | (1.112) | | (4.674) | |
| Observations | 921 | 921 | 296 | 296 | 43 | 43 |
| Standard errors in parentheses<br>*** p<0.01, ** p<0.05, * p<0.1 | | | | | | |

| Variables | Pediatrics | | Psychiatry | | Diagnostic Radiology | |
|---|---|---|---|---|---|---|
| | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** |
| *CivMilGap* | –0.0179*** | –0.00604*** | –0.0224*** | –0.00821*** | –0.00621*** | –0.00210*** |
| | (0.00641) | (0.00216) | (0.00707) | (0.00258) | (0.00178) | (0.000591) |
| *female* | –0.0258 | –0.00873 | 0.0778 | 0.0283 | –0.140 | –0.0486 |
| | (0.160) | (0.0540) | (0.216) | (0.0782) | (0.253) | (0.0901) |
| *male* | **Reference Category** | | | | | |
| *minority* | –0.437** | –0.159** | 0.152 | 0.0544 | –0.249 | –0.0872 |
| | (0.206) | (0.0784) | (0.258) | (0.0902) | (0.223) | (0.0806) |
| *white* | Reference Category | | | | | |
| *lt_lcdr* | –1.494*** | –0.310*** | –1.814*** | –0.514*** | –0.288 | –0.0939 |
| | (0.491) | (0.0508) | (0.478) | (0.0938) | (0.262) | (0.0821) |
| *cdr_cpt* | **Reference Category** | | | | | |
| *YOS* | –0.113 | –0.0384 | –0.230** | –0.0842** | –0.0467 | –0.0158 |
| | (0.0796) | (0.0269) | (0.0910) | (0.0332) | (0.0323) | (0.0109) |
| $YOS^2$ | 0.000183 | 0.0000618 | 0.00268 | 0.000982 | Omitted since *YOS* & $YOS^2$ are not jointly significant | |
| | (0.00297) | (0.00100) | (0.00210) | (0.000767) | | |
| *age* | –0.579** | –0.196** | –0.0297 | –0.0109 | –0.656** | –0.222** |
| | (0.280) | (0.0940) | (0.0351) | (0.0128) | (0.262) | (0.0869) |
| $age^2$ | 0.00688* | 0.00233* | Omitted since *age* & $age^2$ are not jointly significant | | 0.00733** | 0.00248** |
| | (0.00359) | (0.00121) | | | (0.00309) | (0.00102) |
| *None_AFHPSP* | 0.118 | 0.0393 | –0.0528 | –0.0194 | –0.188 | –0.0639 |
| | (0.207) | (0.0678) | (0.214) | (0.0790) | (0.195) | (0.0664) |
| *AFHPSP* | **Reference Category** | | | | | |
| *Post_2004* | –0.103 | –0.0346 | 0.140 | 0.0518 | 0.432* | 0.147* |
| | (0.166) | (0.0556) | (0.223) | (0.0833) | (0.223) | (0.0762) |
| *Prior_2004* | **Reference Category** | | | | | |
| *Constant* | 15.16*** | | 5.912*** | | 16.99*** | |
| | (5.149) | | (1.376) | | (5.626) | |
| Observations | 362 | 362 | 215 | 215 | 286 | 286 |
| Standard errors in parentheses<br>*** p<0.01, ** p<0.05, * p<0.1 | | | | | | |

| Variables | Occupational Medicine | | Urology | |
|---|---|---|---|---|
| | **Probit** | **Marginal Effect** | **Probit** | **Marginal Effect** |
| *CivMilGap* | –0.00301 | –0.000999 | –0.00599* | –0.00208* |
| | (0.00730) | (0.00243) | (0.00344) | (0.00118) |
| *female* | –0.290 | –0.100 | –0.371 | –0.137 |
| | (0.385) | (0.138) | (0.475) | (0.184) |
| *male* | **Reference Category** | | | |
| *minority* | –1.007** | –0.376** | –0.226 | –0.0818 |
| | (0.435) | (0.161) | (0.465) | (0.174) |
| *white* | **Reference Category** | | | |
| *lt_lcdr* | –0.653 | –0.235 | 0.356 | 0.125 |
| | (0.503) | (0.188) | (0.306) | (0.108) |
| *cdr_cpt* | **Reference Category** | | | |
| *YOS* | –0.0546 | –0.0181 | | |
| | (0.0549) | (0.0182) | | |
| $YOS^2$ | Omitted since *YOS & YOS*$^2$ are not jointly significant | | | |
| | | | | |
| *age* | –0.0385 | –0.0128 | | |
| | (0.0487) | (0.0161) | | |
| $age^2$ | Omitted since *age & age*$^2$ are not jointly significant | | | |
| | | | | |
| *None_AFHPSP* | 0.0791 | 0.0262 | –0.0201 | –0.00698 |
| | (0.323) | (0.107) | (0.309) | (0.107) |
| *AFHPSP* | **Reference Category** | | | |
| *Post_2004* | –0.552 | –0.172* | –0.0947 | –0.0328 |
| | (0.360) | (0.102) | (0.334) | (0.116) |
| *Prior_2004* | **Reference Category** | | | |
| *Constant* | 4.254** | | 1.327** | |
| | (1.699) | | (0.571) | |
| Observations | 94 | 94 | 94 | 94 |
| Standard errors in parentheses<br>*** p<0.01, ** p<0.05, * p<0.1 | | | | |

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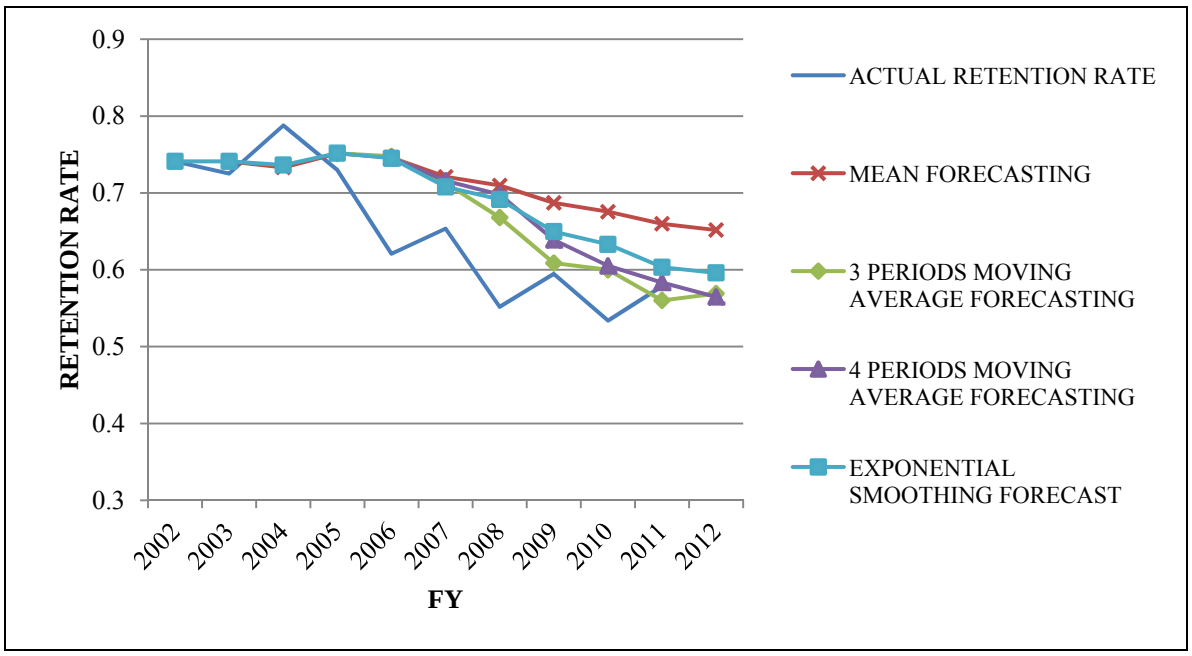
# APPENDIX C. RETENTION PROJECTION MODELS

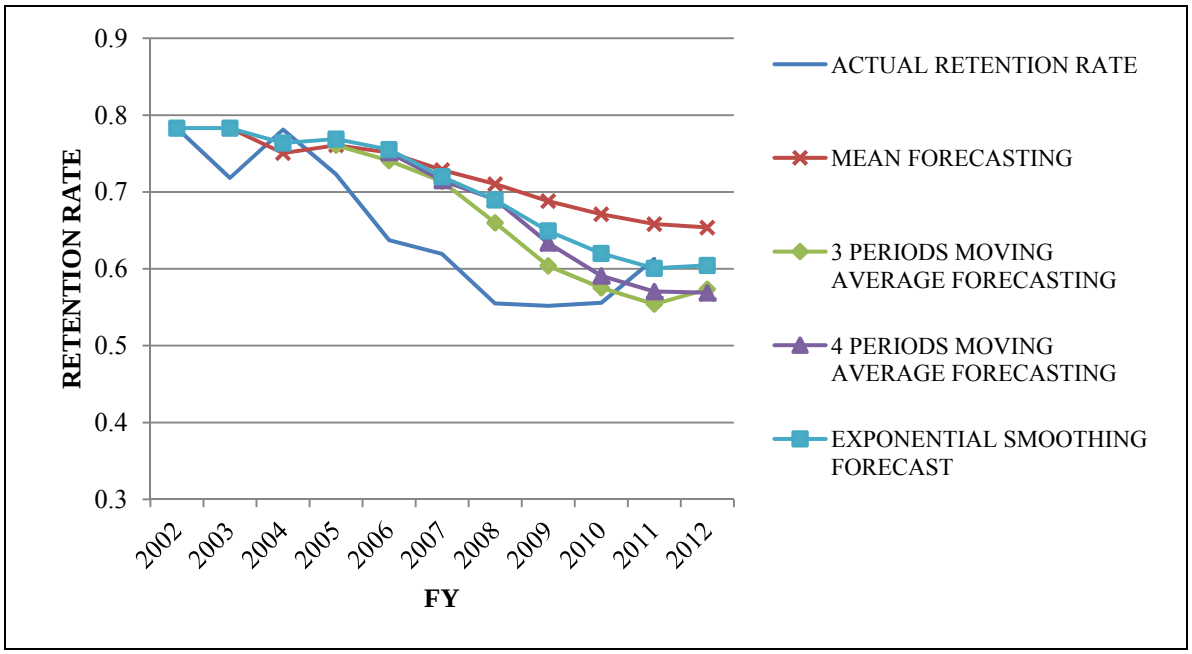
## The Aggregate Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 452 | 158 | 0.740983607 | | | | 0.740983607 |
| 2003 | 417 | 158 | 0.725217391 | 0.740983607 | | | 0.740983607 |
| 2004 | 490 | 132 | 0.787781350 | 0.733100499 | | | 0.736253742 |
| 2005 | 405 | 150 | 0.729729730 | 0.751327449 | 0.751327449 | | 0.751712025 |
| 2006 | 298 | 182 | 0.620833333 | 0.74592802 | 0.747576157 | 0.74592802 | 0.745117336 |
| 2007 | 281 | 149 | 0.653488372 | 0.720909082 | 0.712781471 | 0.715890451 | 0.707832135 |
| 2008 | 192 | 156 | 0.551724138 | 0.709672297 | 0.668017145 | 0.697958196 | 0.691529006 |
| 2009 | 179 | 122 | 0.594684385 | 0.687108274 | 0.608681948 | 0.638943893 | 0.649587546 |
| 2010 | 158 | 138 | 0.533783784 | 0.675555288 | 0.599965632 | 0.605182557 | 0.633116598 |
| 2011 | 151 | 110 | 0.578544061 | 0.659802899 | 0.560064102 | 0.58342017 | 0.603316754 |
| 2012 | | | | 0.651677015 | 0.569004077 | 0.564684092 | 0.595884946 |
| | | | | 90% Upper CI | 0.657182885 | | |
| | | | | 90% Lower CI | 0.480825269 | | |
| | | | MAD | 0.084218064 | 0.060369431 | 0.075710869 | 0.065190824 |
| | | | MSE | 0.009343469 | 0.005498203 | 0.008001261 | 0.0060919 |
| | | | MAPE | 14.15% | 10.21% | 12.98% | 10.84% |
| | | | | | | | Alpha |
| | | | | | | | 0.3 |



## Primary Care Specialists' Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 166 | 46 | 0.783018868 | | | | 0.783018868 |
| 2003 | 153 | 60 | 0.718309859 | 0.783018868 | | | 0.783018868 |
| 2004 | 182 | 51 | 0.781115880 | 0.750664364 | | | 0.763606165 |
| 2005 | 154 | 59 | 0.723004695 | 0.760814869 | 0.760814869 | | 0.76885908 |
| 2006 | 123 | 70 | 0.637305699 | 0.751362325 | 0.740810145 | 0.751362325 | 0.755102764 |
| 2007 | 96 | 59 | 0.619354839 | 0.728551 | 0.713808758 | 0.714934033 | 0.719763645 |
| 2008 | 81 | 65 | 0.554794521 | 0.71035164 | 0.659888411 | 0.690195278 | 0.689641003 |
| 2009 | 64 | 52 | 0.551724138 | 0.688129194 | 0.603818353 | 0.633614938 | 0.649187058 |
| 2010 | 55 | 44 | 0.555555556 | 0.671078562 | 0.575291166 | 0.590794799 | 0.619948182 |
| 2011 | 57 | 36 | 0.612903226 | 0.658242673 | 0.554024738 | 0.570357263 | 0.600630394 |
| 2012 | | | | 0.653708728 | 0.573394306 | 0.56874436 | 0.604312244 |
| | | | | 90% Upper CI | 0.670238973 | | |
| | | | | 90% Lower CI | 0.47654964 | | |
| | | | MAD | 0.089894235 | 0.067367249 | 0.084118764 | 0.072805982 |
| | | | MSE | 0.009964718 | 0.005525575 | 0.008372621 | 0.006948242 |
| | | | MAPE | 14.96% | 11.18% | 14.31% | 11.98% |
| | | | | | | | Alpha |
| | | | | | | | 0.3 |

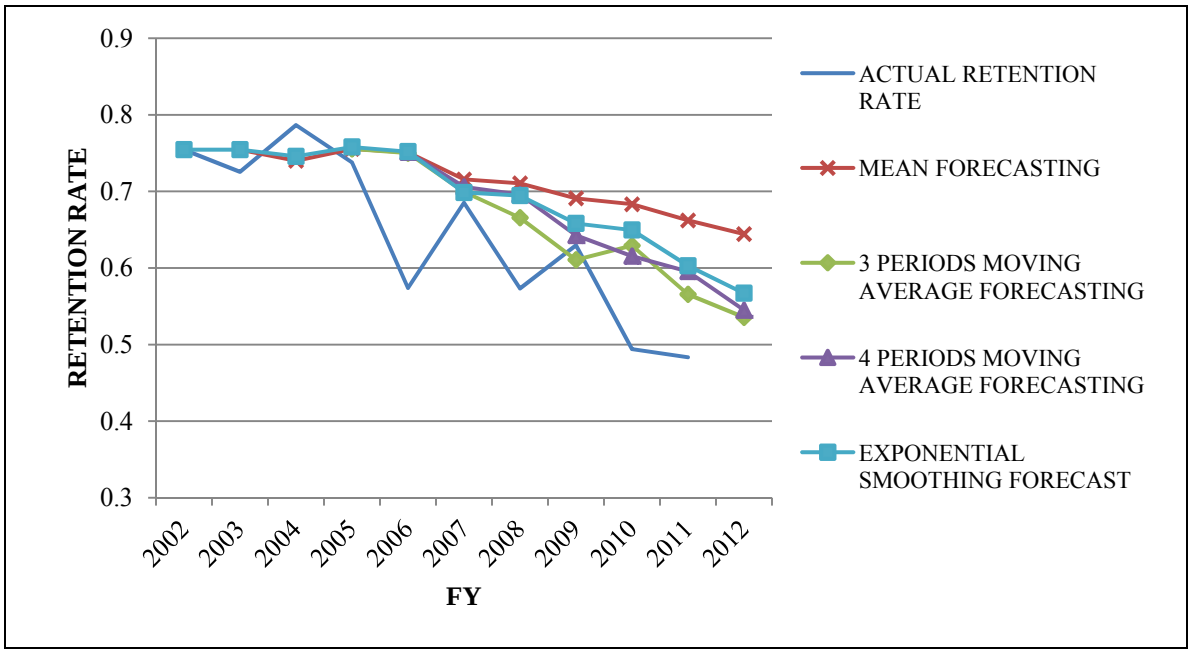


## Surgical Specialists' Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 126 | 41 | 0.754491018 | | | | 0.754491018 |
| 2003 | 119 | 45 | 0.725609756 | 0.754491018 | | | 0.754491018 |
| 2004 | 140 | 38 | 0.786516854 | 0.740050387 | | | 0.745826639 |
| 2005 | 107 | 38 | 0.737931034 | 0.755539209 | 0.755539209 | | 0.758033704 |
| 2006 | 66 | 49 | 0.573913043 | 0.751137166 | 0.750019215 | 0.751137166 | 0.752002903 |
| 2007 | 74 | 34 | 0.685185185 | 0.715692341 | 0.699453644 | 0.705992672 | 0.698575945 |
| 2008 | 47 | 35 | 0.573170732 | 0.710607815 | 0.665676421 | 0.695886529 | 0.694558717 |
| 2009 | 51 | 30 | 0.629629630 | 0.690973946 | 0.61075632 | 0.642549999 | 0.658142322 |
| 2010 | 41 | 42 | 0.493975904 | 0.683305907 | 0.629328516 | 0.615474648 | 0.649588514 |
| 2011 | 29 | 31 | 0.483333333 | 0.66226924 | 0.565592088 | 0.595490363 | 0.602904731 |
| 2012 | | | | 0.644375649 | 0.535646289 | 0.5450274 | 0.567033312 |
| | | | | | | 90% upper CI | 0.691046387 |
| | | | | | | 90% lower CI | 0.443020236 |

| | | | | |
|---|---|---|---|---|
| MAD | 0.096414943 | 0.076710453 | 0.094553925 | 0.07847105 |
| MSE | 0.014017597 | 0.009361051 | 0.012401431 | 0.009872208 |
| MAPE | 17.41% | 14.10% | 17.53% | 14.09% |

| Alpha |
|---|
| 0.3 |

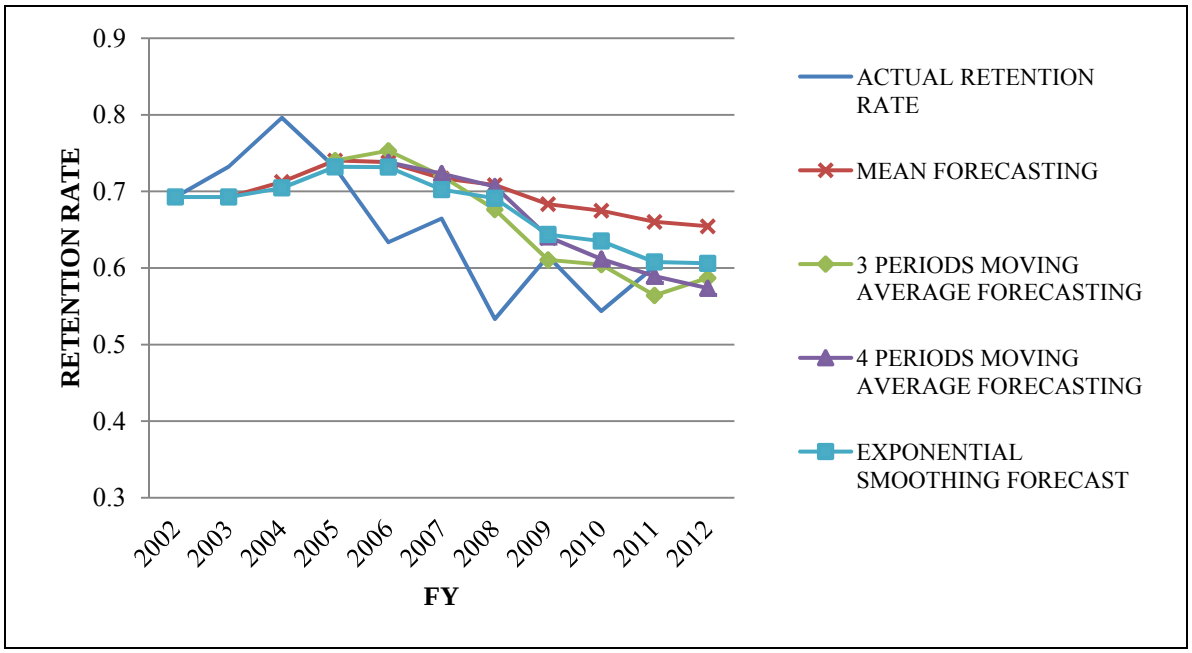


## Other Specialties Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 160 | 71 | 0.692640693 | | | | 0.692640693 |
| 2003 | 145 | 53 | 0.732323232 | 0.692640693 | | | 0.692640693 |
| 2004 | 168 | 43 | 0.796208531 | 0.712481962 | | | 0.704545455 |
| 2005 | 144 | 53 | 0.730964467 | 0.740390819 | 0.740390819 | | 0.732044377 |
| 2006 | 109 | 63 | 0.633720930 | 0.738034231 | 0.75316541 | 0.738034231 | 0.731720404 |
| 2007 | 111 | 56 | 0.664670659 | 0.717171571 | 0.720297976 | 0.72330429 | 0.702320562 |
| 2008 | 64 | 56 | 0.533333333 | 0.708421419 | 0.676452019 | 0.706391147 | 0.691025591 |
| 2009 | 64 | 40 | 0.615384615 | 0.683408835 | 0.610574974 | 0.640672347 | 0.643717914 |
| 2010 | 62 | 52 | 0.543859649 | 0.674905808 | 0.604462869 | 0.611777384 | 0.635217924 |
| 2011 | 65 | 43 | 0.601851852 | 0.660345123 | 0.564192533 | 0.589312064 | 0.607810442 |
| 2012 | | | | 0.654495796 | 0.587032039 | 0.573607362 | 0.606022865 |
| | | | | | | 90% upper CI | 0.730473851 |
| | | | | | | 90% lower CI | 0.481571879 |

| | | | | |
|---|---|---|---|---|
| MAD | 0.080255712 | 0.061527002 | 0.073625 | 0.061268592 |
| MSE | 0.008687667 | 0.006149615 | 0.008279618 | 0.006116763 |
| MAPE | 13.25% | 10.50% | 12.74% | 10.02% |

| Alpha |
|---|
| 0.3 |

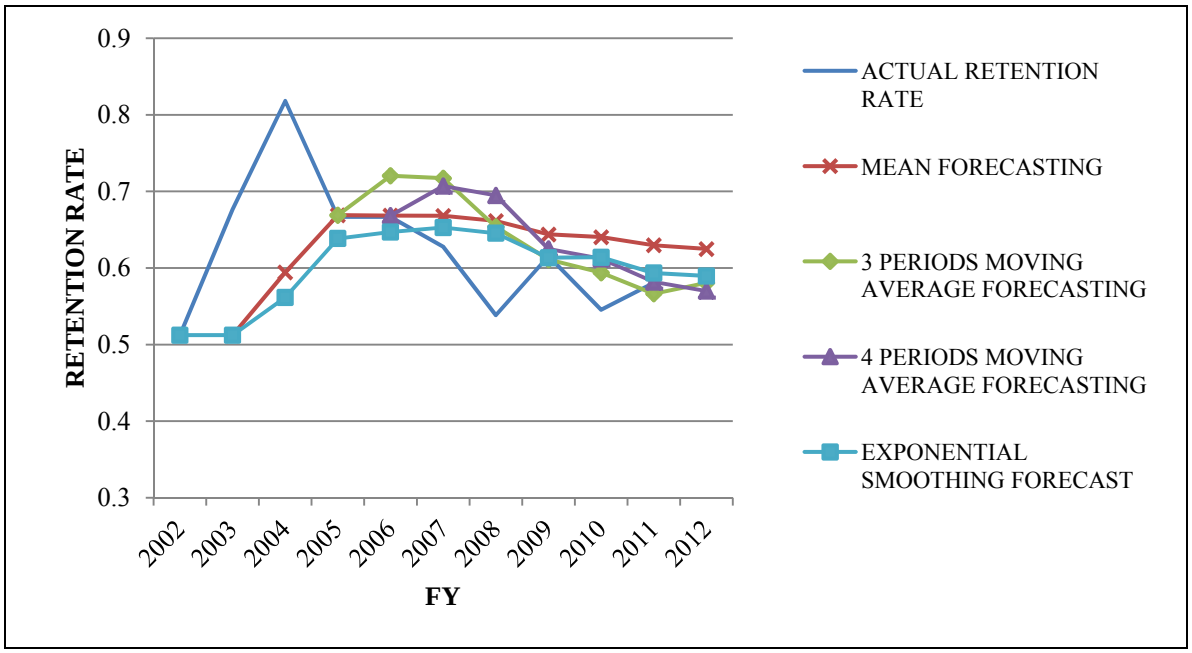


## Anesthesiologists' Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 21 | 20 | 0.512195122 | | | | 0.512195122 |
| 2003 | 23 | 11 | 0.676470588 | 0.512195122 | | | 0.512195122 |
| 2004 | 36 | 8 | 0.818181818 | 0.594332855 | | | 0.561477762 |
| 2005 | 32 | 16 | 0.666666667 | 0.668949176 | 0.668949176 | | 0.638488979 |
| 2006 | 28 | 14 | 0.666666667 | 0.668378549 | 0.720439691 | 0.668378549 | 0.646942285 |
| 2007 | 27 | 16 | 0.627906977 | 0.668036172 | 0.717171717 | 0.706996435 | 0.6528596 |
| 2008 | 14 | 12 | 0.538461538 | 0.661347973 | 0.65374677 | 0.694855532 | 0.645373813 |
| 2009 | 16 | 10 | 0.615384615 | 0.643792768 | 0.611011727 | 0.624925462 | 0.61330013 |
| 2010 | 18 | 15 | 0.545454545 | 0.640241749 | 0.59391771 | 0.612104949 | 0.613925476 |
| 2011 | 18 | 13 | 0.580645161 | 0.629709838 | 0.566433566 | 0.581801919 | 0.593384197 |
| 2012 | | | | 0.62480337 | 0.580494774 | 0.569986465 | 0.589562486 |
| | | | | 90% upper CI | 0.661837651 | | |
| | | | | 90% lower CI | 0.499151898 | | |

| | | | | |
|---|---|---|---|---|
| MAD | 0.080821609 | 0.046807593 | 0.05242389 | 0.076004549 |
| MSE | 0.011779259 | 0.003817914 | 0.005875299 | 0.012330467 |
| MAPE | 12.43% | 8.01% | 9.31% | 11.31% |

| Alpha |
|---|
| 0.3 |

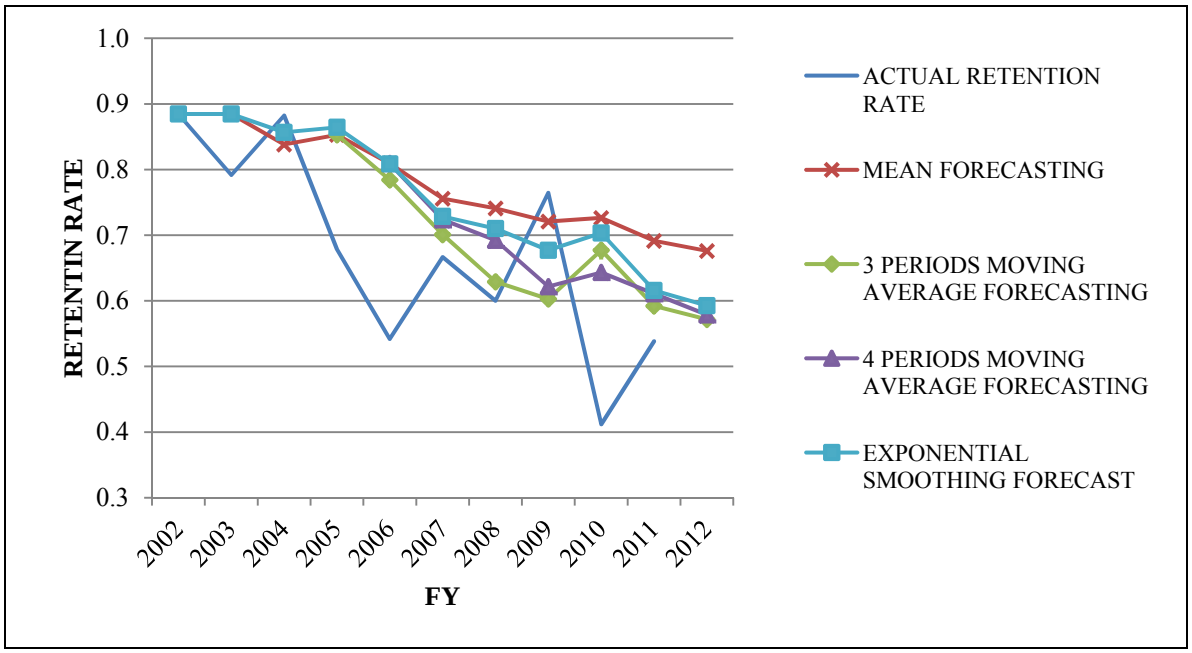


## General Surgeons' Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 23 | 3 | 0.884615385 | | | | 0.884615385 |
| 2003 | 19 | 5 | 0.791666667 | 0.884615385 | | | 0.884615385 |
| 2004 | 30 | 4 | 0.882352941 | 0.838141026 | | | 0.856730769 |
| 2005 | 19 | 9 | 0.678571429 | 0.852878331 | 0.852878331 | | 0.864417421 |
| 2006 | 13 | 11 | 0.541666667 | 0.809301605 | 0.784197012 | 0.809301605 | 0.808663623 |
| 2007 | 14 | 7 | 0.666666667 | 0.755774618 | 0.700863679 | 0.723564426 | 0.728564536 |
| 2008 | 9 | 6 | 0.600000000 | 0.740923292 | 0.628968254 | 0.692314426 | 0.709995175 |
| 2009 | 13 | 4 | 0.764705882 | 0.720791393 | 0.602777778 | 0.62172619 | 0.676996623 |
| 2010 | 7 | 10 | 0.411764706 | 0.726280705 | 0.677124183 | 0.643259804 | 0.703309401 |
| 2011 | 7 | 6 | 0.538461538 | 0.691334483 | 0.592156863 | 0.610784314 | 0.615845992 |
| 2012 | | | | 0.676047188 | 0.571644042 | 0.578733032 | 0.592630656 |
| | | | | | | 90% upper CI | 0.797826473 |
| | | | | | | 90% lower CI | 0.387434839 |

| | | | | |
|---|---|---|---|---|
| MAD | 0.146715239 | 0.137283631 | 0.143940781 | 0.133327255 |
| MSE | 0.029402672 | 0.02724743 | 0.027108588 | 0.02552577 |
| MAPE | 26.58% | 25.14% | 26.95% | 23.95% |

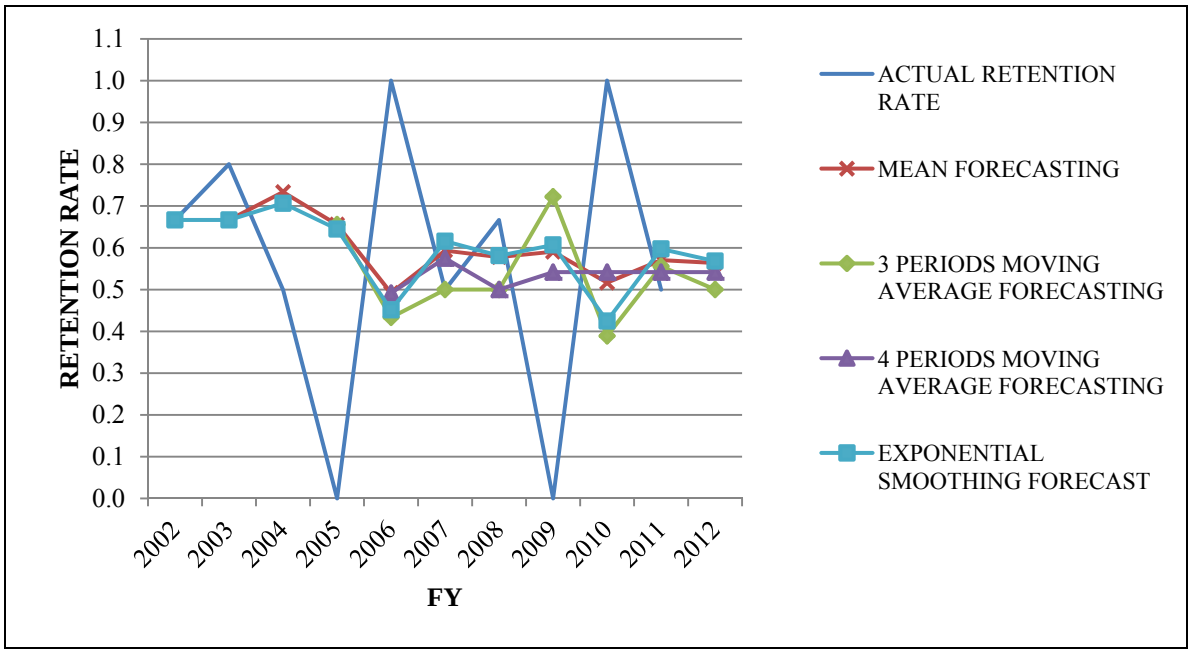
| Alpha |
|---|
| 0.3 |



## Neurological Surgeons' Retention Model

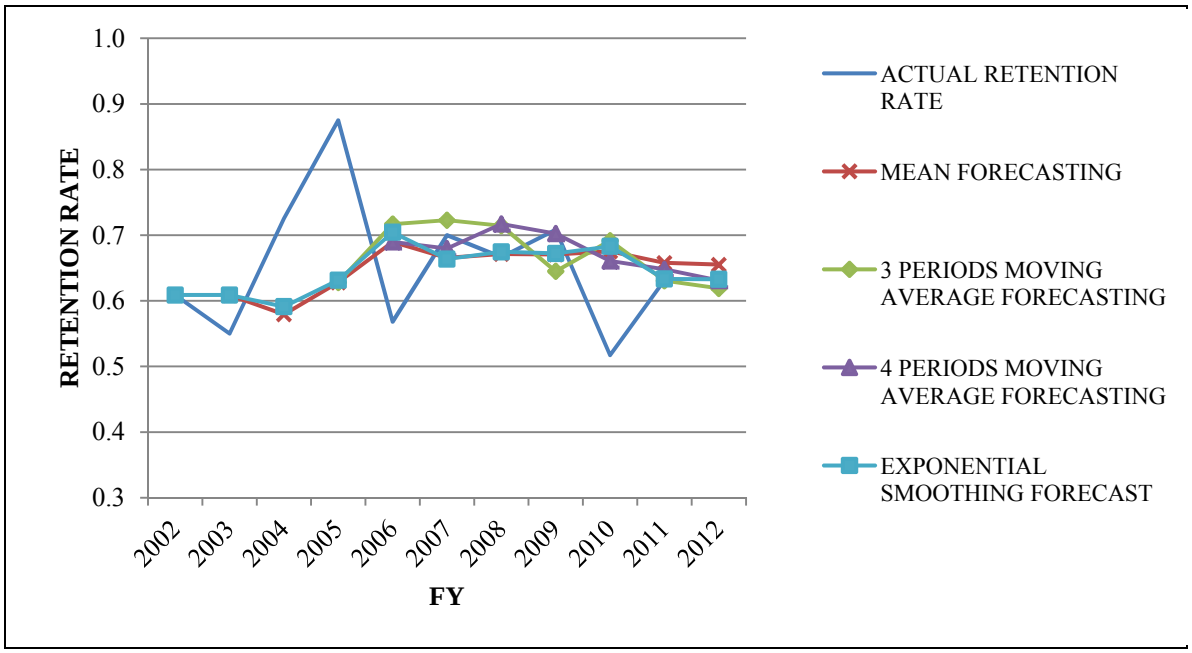
| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 2 | 1 | 0.666666667 | | | | 0.666666667 |
| 2003 | 4 | 1 | 0.800000000 | 0.666666667 | | | 0.666666667 |
| 2004 | 3 | 3 | 0.500000000 | 0.733333333 | | | 0.706666667 |
| 2005 | 0 | 2 | 0.000000000 | 0.655555556 | 0.655555556 | | 0.644666667 |
| 2006 | 1 | 0 | 1.000000000 | 0.491666667 | 0.433333333 | 0.491666667 | 0.451266667 |
| 2007 | 1 | 1 | 0.500000000 | 0.593333333 | 0.5 | 0.575 | 0.615886667 |
| 2008 | 2 | 1 | 0.666666667 | 0.577777778 | 0.5 | 0.5 | 0.581120667 |
| 2009 | 0 | 2 | 0.000000000 | 0.59047619 | 0.722222222 | 0.541666667 | 0.606784467 |
| 2010 | 1 | 0 | 1.000000000 | 0.516666667 | 0.388888889 | 0.541666667 | 0.424749127 |
| 2011 | 1 | 1 | 0.500000000 | 0.57037037 | 0.555555556 | 0.541666667 | 0.597324389 |
| 2012 | | | | 0.563333333 | 0.5 | 0.541666667 | 0.568127072 |
| | | | | | 90% upper CI | 1.182756628 | |
| | | | | | 90% lower CI | -0.099423295 | |
| | | | MAD | 0.317439741 | 0.396825397 | 0.298611111 | 0.334910266 |
| | | | MSE | 0.151579518 | 0.239541446 | 0.132835648 | 0.167390345 |
| | | | MAPE | N/A | N/A | N/A | N/A |
| | | | | | | | Alpha |
| | | | | | | | 0.3 |

(N/A) Not Applicable



## OB/GYN Specialists' Retention Projection Model

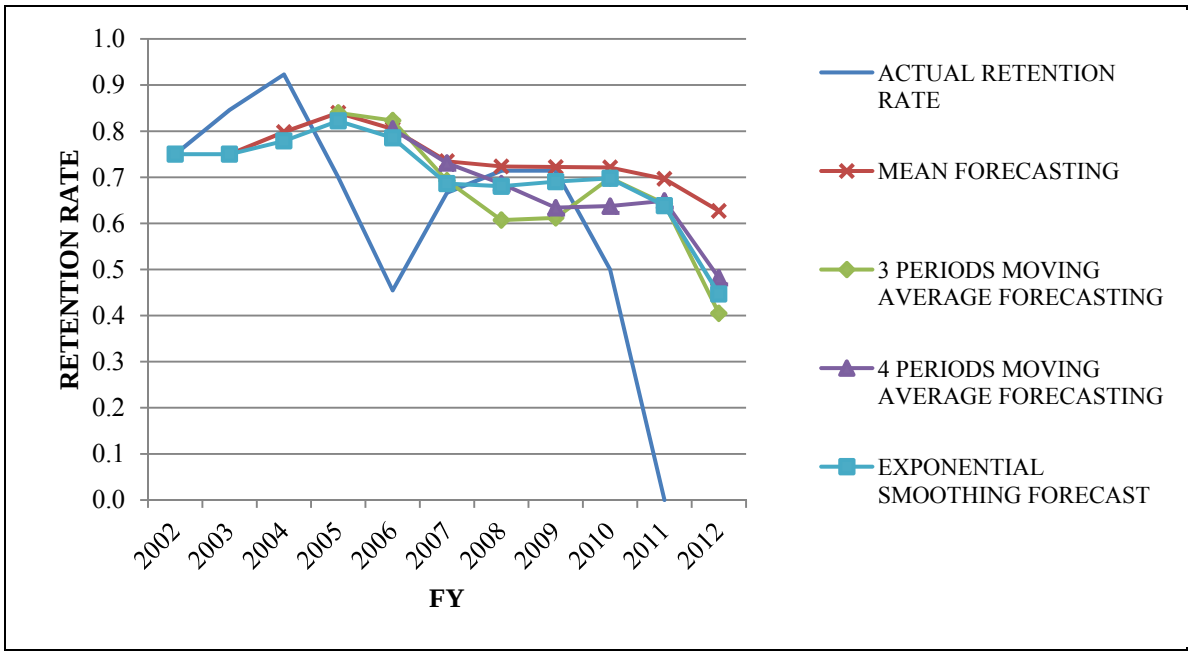
| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 28 | 18 | 0.608695652 | | | | 0.608695652 |
| 2003 | 22 | 18 | 0.550000000 | 0.608695652 | | | 0.608695652 |
| 2004 | 37 | 14 | 0.725490196 | 0.579347826 | | | 0.591086957 |
| 2005 | 42 | 6 | 0.875000000 | 0.628061949 | 0.628061949 | | 0.631407928 |
| 2006 | 25 | 19 | 0.568181818 | 0.689796462 | 0.716830065 | 0.689796462 | 0.70448555 |
| 2007 | 21 | 9 | 0.700000000 | 0.665473533 | 0.722890671 | 0.679668004 | 0.66359443 |
| 2008 | 12 | 6 | 0.666666667 | 0.671227944 | 0.714393939 | 0.717168004 | 0.674516101 |
| 2009 | 17 | 7 | 0.708333333 | 0.670576333 | 0.644949495 | 0.702462121 | 0.672161271 |
| 2010 | 15 | 14 | 0.517241379 | 0.675295958 | 0.691666667 | 0.660795455 | 0.68301289 |
| 2011 | 12 | 7 | 0.631578947 | 0.657734338 | 0.630747126 | 0.648060345 | 0.633281437 |
| 2012 | | | | 0.655118799 | 0.61905122 | 0.630955082 | 0.63277069 |
| | | | | | 90% upper CI | 0.742686929 | |
| | | | | | 90% lower CI | 0.519223234 | |
| | | | MAD | 0.092716159 | 0.10069217 | 0.059725777 | 0.09121064 |
| | | | MSE | 0.014319458 | 0.017188423 | 0.006444629 | 0.014400412 |
| | | | MAPE | 14.01% | 15.37% | 10.51% | 13.87% |
| | | | | | | | Alpha |
| | | | | | | | 0.3 |



## Ophthalmologists' Retention Projection Model

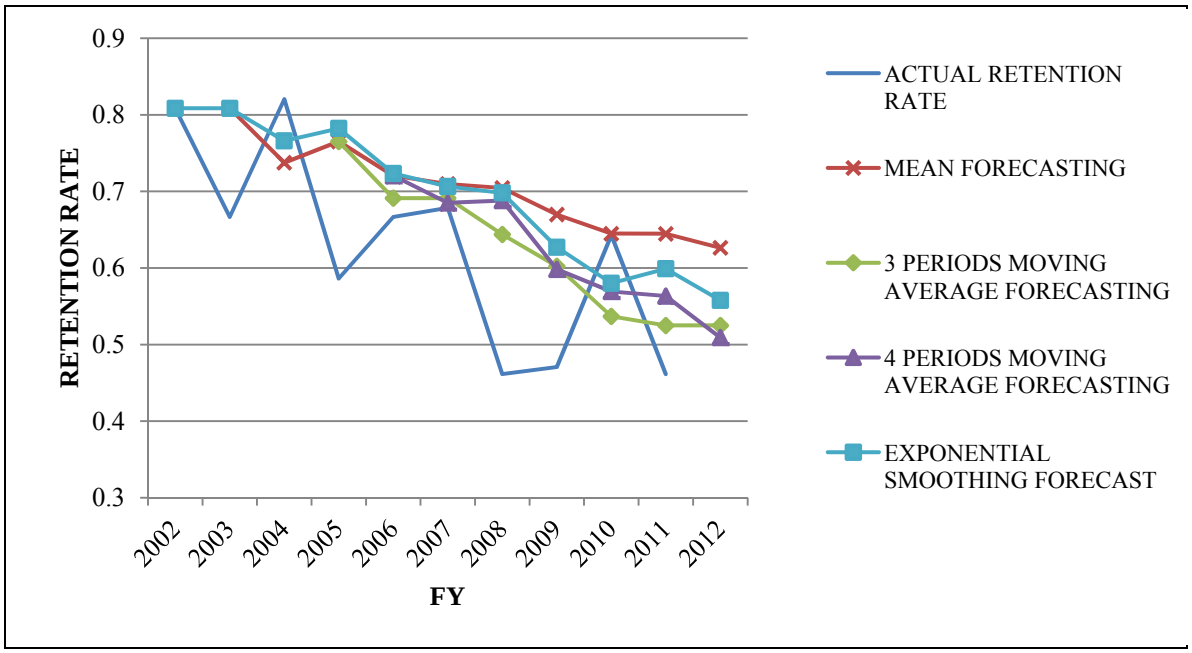
| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 9 | 3 | 0.750000000 | | | | 0.75 |
| 2003 | 11 | 2 | 0.846153846 | 0.75 | | | 0.75 |
| 2004 | 12 | 1 | 0.923076923 | 0.798076923 | | | 0.778846154 |
| 2005 | 7 | 3 | 0.700000000 | 0.83974359 | 0.83974359 | | 0.822115385 |
| 2006 | 5 | 6 | 0.454545455 | 0.804807692 | 0.823076923 | 0.804807692 | 0.785480769 |
| 2007 | 8 | 4 | 0.666666667 | 0.734755245 | 0.692540793 | 0.730944056 | 0.686200175 |
| 2008 | 5 | 2 | 0.714285714 | 0.723407148 | 0.607070707 | 0.686072261 | 0.680340122 |
| 2009 | 5 | 2 | 0.714285714 | 0.722104086 | 0.611832612 | 0.633874459 | 0.6905238 |
| 2010 | 4 | 4 | 0.500000000 | 0.72112679 | 0.698412698 | 0.637445887 | 0.697652374 |
| 2011 | 0 | 3 | 0.000000000 | 0.696557147 | 0.642857143 | 0.648809524 | 0.638356662 |
| 2012 | | | | 0.626901432 | 0.404761905 | 0.482142857 | 0.446849663 |
| | | | | | | 90% upper CI | 0.853835786 |
| | | | | | | 90% lower CI | 0.03986354 |
| | | | MAD | 0.190430222 | 0.226441019 | 0.218236624 | 0.178520596 |
| | | | MSE | 0.078439085 | 0.090091112 | 0.095653726 | 0.067015845 |
| | | | MAPE | N/A | N/A | N/A | N/A |
| | | | | | | | Alpha |
| | | | | | | | 0.3 |

(N/A) Not Applicable



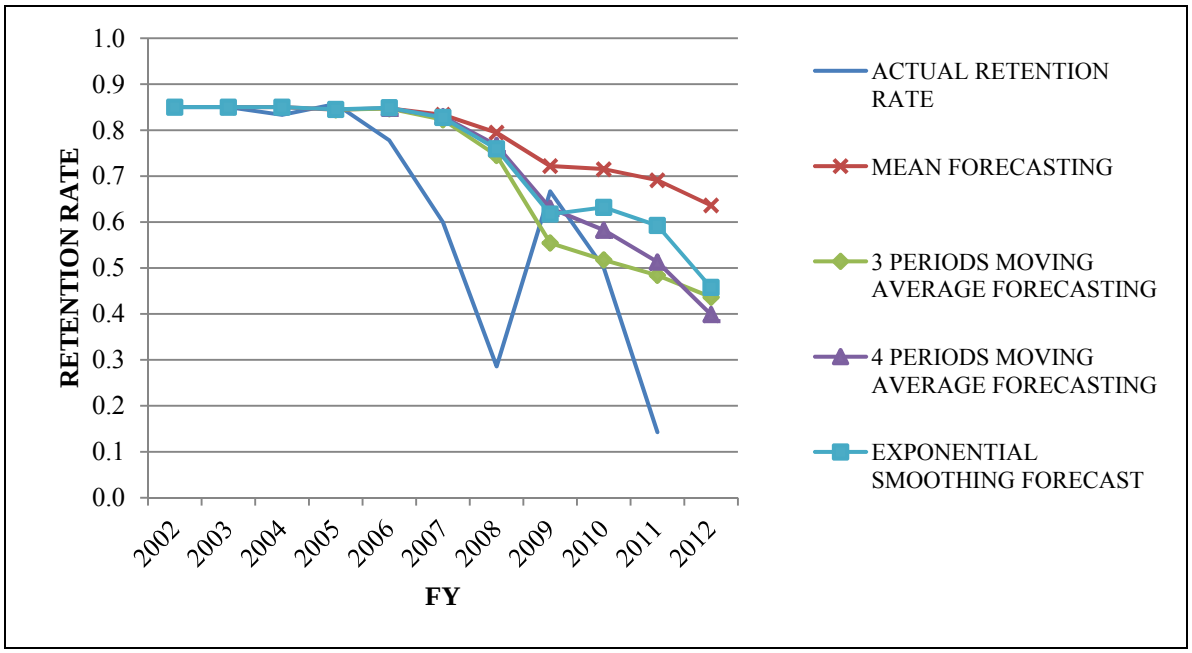
## Orthopedic Surgeons' Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 38 | 9 | 0.808510638 | | | | 0.808510638 |
| 2003 | 30 | 15 | 0.666666667 | 0.808510638 | | | 0.808510638 |
| 2004 | 32 | 7 | 0.820512821 | 0.737588652 | | | 0.765957447 |
| 2005 | 17 | 12 | 0.586206897 | 0.765230042 | 0.765230042 | | 0.782324059 |
| 2006 | 14 | 7 | 0.666666667 | 0.720474256 | 0.691128795 | 0.720474256 | 0.72348891 |
| 2007 | 19 | 9 | 0.678571429 | 0.709712738 | 0.691128795 | 0.685013263 | 0.706442237 |
| 2008 | 12 | 14 | 0.461538462 | 0.70452252 | 0.643814997 | 0.687989453 | 0.698080995 |
| 2009 | 8 | 9 | 0.470588235 | 0.669810511 | 0.602258852 | 0.598245863 | 0.627118235 |
| 2010 | 9 | 5 | 0.642857143 | 0.644907727 | 0.536899375 | 0.569341198 | 0.580159235 |
| 2011 | 6 | 7 | 0.461538462 | 0.644679884 | 0.524994613 | 0.563388817 | 0.598968607 |
| 2012 | | | | 0.626365742 | 0.524994613 | 0.509130575 | 0.557739564 |
| | | | | 90% upper CI | 0.695778761 | | |
| | | | | 90% lower CI | 0.354210465 | | |
| | | | MAD | 0.124015391 | 0.099914816 | 0.09828739 | 0.118934461 |
| | | | MSE | 0.021687356 | 0.014088713 | 0.014381894 | 0.018759508 |
| | | | MAPE | 23.28% | 19.11% | 19.79% | 22.01% |
| | | | | | | | Alpha |
| | | | | | | | 0.3 |



## Otolaryngologists' Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 17 | 3 | 0.850000000 | | | | 0.85 |
| 2003 | 17 | 3 | 0.850000000 | 0.85 | | | 0.85 |
| 2004 | 15 | 3 | 0.833333333 | 0.85 | | | 0.85 |
| 2005 | 12 | 2 | 0.857142857 | 0.844444444 | 0.844444444 | | 0.845 |
| 2006 | 7 | 2 | 0.777777778 | 0.847619048 | 0.846825397 | 0.847619048 | 0.848642857 |
| 2007 | 6 | 4 | 0.600000000 | 0.833650794 | 0.822751323 | 0.829563492 | 0.827383333 |
| 2008 | 2 | 5 | 0.285714286 | 0.794708995 | 0.744973545 | 0.767063492 | 0.759168333 |
| 2009 | 4 | 2 | 0.666666667 | 0.721995465 | 0.554497354 | 0.63015873 | 0.617132119 |
| 2010 | 4 | 4 | 0.500000000 | 0.715079365 | 0.517460317 | 0.582539683 | 0.631992483 |
| 2011 | 1 | 6 | 0.142857143 | 0.691181658 | 0.484126984 | 0.513095238 | 0.592394738 |
| 2012 | | | | 0.636349206 | 0.436507937 | 0.398809524 | 0.45753346 |
| | | | | | | 90% upper CI | 0.782971393 |
| | | | | | | 90% lower CI | 0.132095526 |
| | | | MAD | 0.184509392 | 0.176379441 | 0.21167328 | 0.159064068 |
| | | | MSE | 0.07432948 | 0.056402566 | 0.072416022 | 0.055918749 |
| | | | MAPE | 73.85% | 66.78% | 82.81% | 62.74% |
| | | | | | | | Alpha |
| | | | | | | | 0.3 |

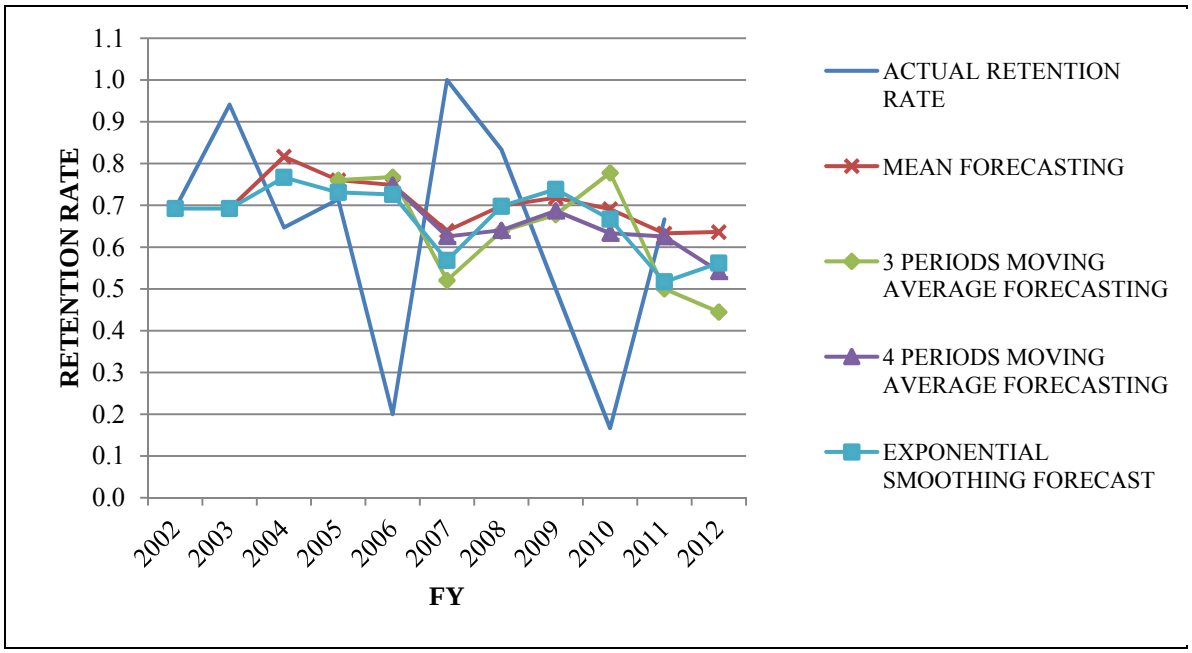


## Urologists' Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 9 | 4 | 0.692307692 | | | | 0.692307692 |
| 2003 | 16 | 1 | 0.941176471 | 0.692307692 | | | 0.692307692 |
| 2004 | 11 | 6 | 0.647058824 | 0.816742081 | | | 0.766968326 |
| 2005 | 10 | 4 | 0.714285714 | 0.760180995 | 0.760180995 | | 0.730995475 |
| 2006 | 1 | 4 | 0.200000000 | 0.748707175 | 0.767507003 | 0.748707175 | 0.725982547 |
| 2007 | 5 | 0 | 1.000000000 | 0.63896574 | 0.520448179 | 0.625630252 | 0.568187783 |
| 2008 | 5 | 1 | 0.833333333 | 0.699138117 | 0.638095238 | 0.640336134 | 0.697731448 |
| 2009 | 4 | 4 | 0.500000000 | 0.718308862 | 0.677777778 | 0.686904762 | 0.738412014 |
| 2010 | 1 | 5 | 0.166666667 | 0.691020254 | 0.777777778 | 0.633333333 | 0.66688841 |
| 2011 | 2 | 1 | 0.666666667 | 0.632758745 | 0.5 | 0.625 | 0.516821887 |
| 2012 | | | | 0.636149537 | 0.444444444 | 0.541666667 | 0.561775321 |
| | | | | | | 90% upper CI | 1.103184214 |
| | | | | | | 90% lower CI | 0.020366427 |

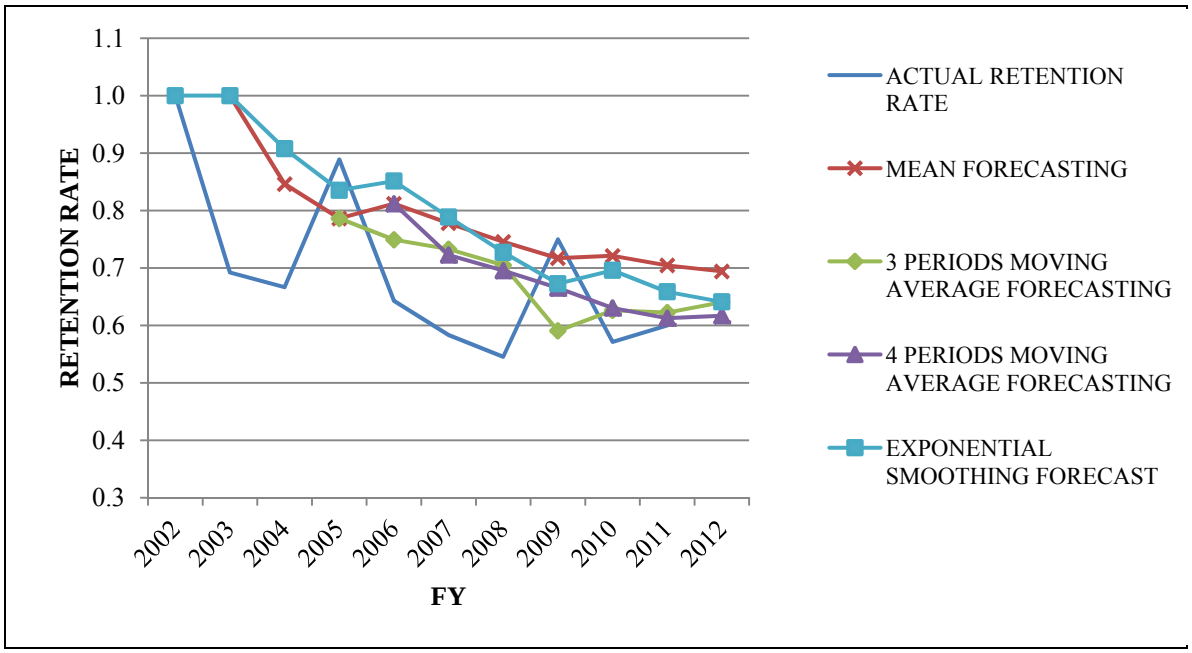
| | | | | |
|---|---|---|---|---|
| MAD | 0.253883816 | 0.320535394 | 0.30188537 | 0.263040359 |
| MSE | 0.096224811 | 0.146442563 | 0.122154578 | 0.098624002 |
| MAPE | 83.22% | 112.68% | 109.76% | 82.23% |

| Alpha |
|---|
| 0.3 |



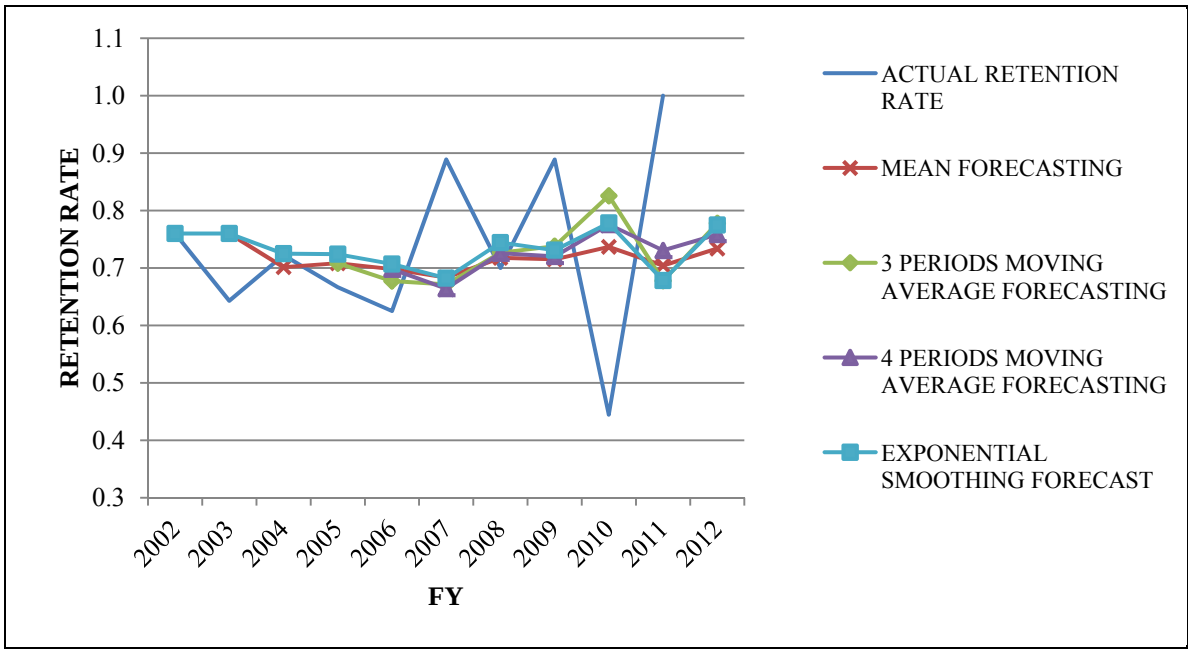
## Occupational Medicine Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 10 | 0 | 1.000000000 | | | | 1 |
| 2003 | 9 | 4 | 0.692307692 | 1 | | | 1 |
| 2004 | 6 | 3 | 0.666666667 | 0.846153846 | | | 0.907692308 |
| 2005 | 8 | 1 | 0.888888889 | 0.786324786 | 0.786324786 | | 0.835384615 |
| 2006 | 9 | 5 | 0.642857143 | 0.811965812 | 0.749287749 | 0.811965812 | 0.851435897 |
| 2007 | 7 | 5 | 0.583333333 | 0.778144078 | 0.732804233 | 0.722680098 | 0.788862271 |
| 2008 | 6 | 5 | 0.545454545 | 0.745675621 | 0.705026455 | 0.695436508 | 0.72720359 |
| 2009 | 3 | 1 | 0.750000000 | 0.71707261 | 0.590548341 | 0.665133478 | 0.672678876 |
| 2010 | 4 | 3 | 0.571428571 | 0.721188534 | 0.626262626 | 0.630411255 | 0.695875214 |
| 2011 | 3 | 2 | 0.600000000 | 0.704548538 | 0.622294372 | 0.612554113 | 0.658541221 |
| 2012 | | | | 0.694093684 | 0.64047619 | 0.616720779 | 0.640978855 |
| | | | | 90% upper CI | 0.843045714 | | |
| | | | | 90% lower CI | 0.437906667 | | |
| | | | MAD | 0.160124441 | 0.107802515 | 0.102473452 | 0.162043105 |
| | | | MSE | 0.0309433 | 0.014082894 | 0.013558124 | 0.033255909 |
| | | | MAPE | 25.26% | 16.79% | 16.90% | 25.50% |
| | | | | | | | Alpha |
| | | | | | | | 0.3 |



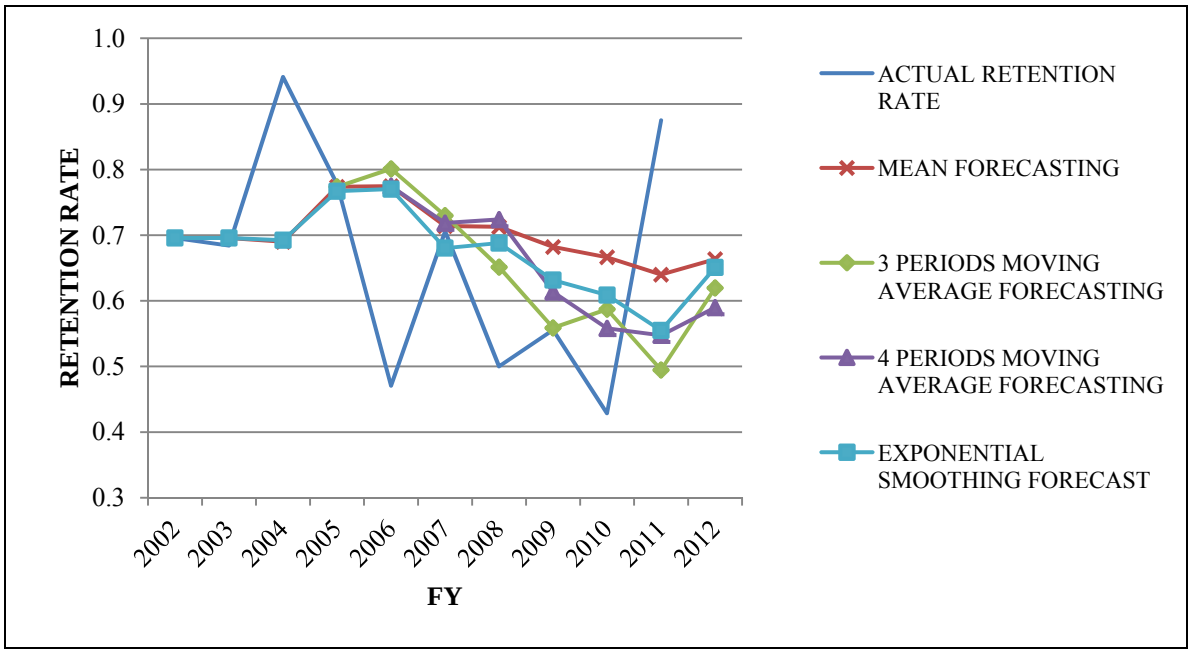
## Pathologists' Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 19 | 6 | 0.760000000 | | | | 0.76 |
| 2003 | 9 | 5 | 0.642857143 | 0.76 | | | 0.76 |
| 2004 | 13 | 5 | 0.722222222 | 0.701428571 | | | 0.724857143 |
| 2005 | 8 | 4 | 0.666666667 | 0.708359788 | 0.708359788 | | 0.724066667 |
| 2006 | 5 | 3 | 0.625000000 | 0.697936508 | 0.677248677 | 0.697936508 | 0.706846667 |
| 2007 | 8 | 1 | 0.888888889 | 0.683349206 | 0.671296296 | 0.664186508 | 0.682292667 |
| 2008 | 7 | 3 | 0.700000000 | 0.71760582 | 0.726851852 | 0.725694444 | 0.744271533 |
| 2009 | 8 | 1 | 0.888888889 | 0.715090703 | 0.737962963 | 0.720138889 | 0.730990073 |
| 2010 | 4 | 5 | 0.444444444 | 0.736815476 | 0.825925926 | 0.775694444 | 0.778359718 |
| 2011 | 5 | 0 | 1.000000000 | 0.704329806 | 0.677777778 | 0.730555556 | 0.678185136 |
| 2012 | | | | 0.733896825 | 0.777777778 | 0.758333333 | 0.774729595 |
| | | | 90% upper CI | 1.032861711 | | | |
| | | | 90% lower CI | 0.43493194 | | | |
| | | | MAD | 0.137505672 | 0.170430839 | 0.18212963 | 0.147057906 |
| | | | MSE | 0.029652988 | 0.046381388 | 0.044545755 | 0.034262361 |
| | | | MAPE | 19.95% | 25.42% | 26.85% | 21.66% |
| | | | | | | | Alpha |
| | | | | | | | 0.3 |



## Dermatologists' Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 16 | 7 | 0.695652174 | | | | 0.695652174 |
| 2003 | 13 | 6 | 0.684210526 | 0.695652174 | | | 0.695652174 |
| 2004 | 16 | 1 | 0.941176471 | 0.68993135 | | | 0.69221968 |
| 2005 | 14 | 4 | 0.777777778 | 0.773679724 | 0.773679724 | | 0.766906717 |
| 2006 | 8 | 9 | 0.470588235 | 0.774704237 | 0.801054925 | 0.774704237 | 0.770168035 |
| 2007 | 12 | 5 | 0.705882353 | 0.713881037 | 0.729847495 | 0.718438252 | 0.680294095 |
| 2008 | 6 | 6 | 0.500000000 | 0.712547923 | 0.651416122 | 0.723856209 | 0.687970573 |
| 2009 | 5 | 4 | 0.555555556 | 0.682183934 | 0.558823529 | 0.613562092 | 0.631579401 |
| 2010 | 3 | 4 | 0.428571429 | 0.666355387 | 0.587145969 | 0.558006536 | 0.608772247 |
| 2011 | 7 | 1 | 0.875000000 | 0.639934947 | 0.494708995 | 0.547502334 | 0.554712002 |
| 2012 | | | | 0.663441452 | 0.619708995 | 0.589781746 | 0.650798401 |
| | | | | | | 90% upper CI | 0.983029818 |
| | | | | | | 90% lower CI | 0.318566984 |
| | | | MAD | 0.154547202 | 0.150297075 | 0.175911237 | 0.151213421 |
| | | | MSE | 0.036536721 | 0.043214859 | 0.045021454 | 0.03653341 |
| | | | MAPE | 26.92% | 26.50% | 31.54% | 25.19% |
| | | | | | | | Alpha |
| | | | | | | | 0.3 |

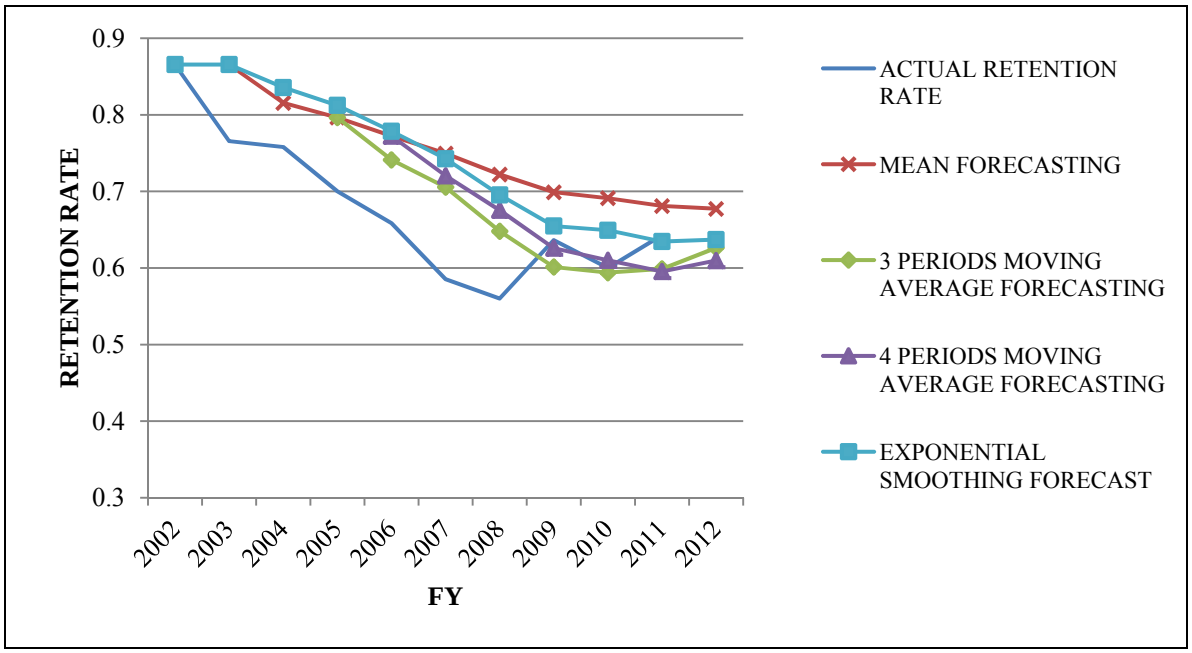


## Emergency Medicine's Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 58 | 9 | 0.865671642 | | | | 0.865671642 |
| 2003 | 49 | 15 | 0.765625000 | 0.865671642 | | | 0.865671642 |
| 2004 | 47 | 15 | 0.758064516 | 0.815648321 | | | 0.835657649 |
| 2005 | 35 | 15 | 0.700000000 | 0.796453719 | 0.796453719 | | 0.812379709 |
| 2006 | 27 | 14 | 0.658536585 | 0.772340289 | 0.741229839 | 0.772340289 | 0.778665797 |
| 2007 | 24 | 17 | 0.585365854 | 0.749579549 | 0.7055337 | 0.720556525 | 0.742627033 |
| 2008 | 14 | 11 | 0.560000000 | 0.722210599 | 0.64796748 | 0.675491739 | 0.695448679 |
| 2009 | 14 | 8 | 0.636363636 | 0.699037657 | 0.601300813 | 0.62597561 | 0.654814076 |
| 2010 | 15 | 10 | 0.600000000 | 0.691203404 | 0.59390983 | 0.610066519 | 0.649278944 |
| 2011 | 18 | 10 | 0.642857143 | 0.681069693 | 0.598787879 | 0.595432373 | 0.634495261 |
| 2012 | | | | 0.677248438 | 0.626406926 | 0.609805195 | 0.637003825 |
| | | | | 90% upper CI | 0.73976949 | | |
| | | | | 90% lower CI | 0.513044363 | | |

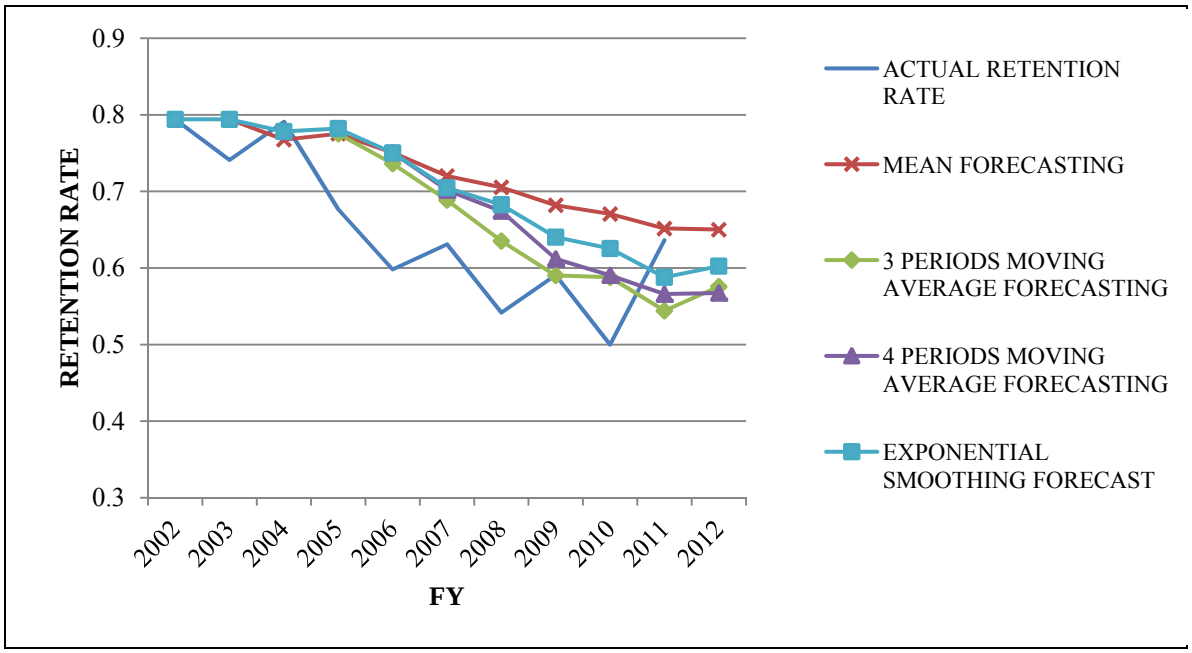
| | | | | |
|---|---|---|---|---|
| MAD | 0.098489127 | 0.067500651 | 0.072060905 | 0.08654998 |
| MSE | 0.01139606 | 0.005932668 | 0.007837416 | 0.009889603 |
| MAPE | 15.53% | 10.85% | 11.95% | 13.45% |

| Alpha |
|---|
| 0.3 |



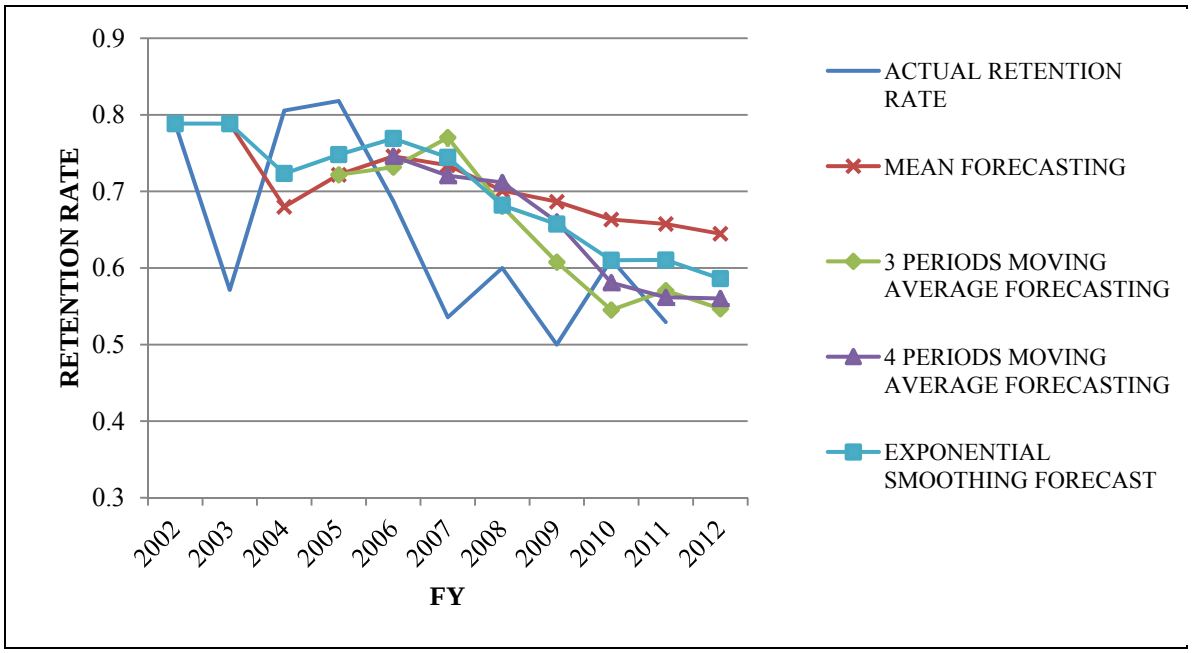
## Family Practice Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 81 | 21 | 0.794117647 | | | | 0.794117647 |
| 2003 | 83 | 29 | 0.741071429 | 0.794117647 | | | 0.794117647 |
| 2004 | 106 | 28 | 0.791044776 | 0.767594538 | | | 0.778203782 |
| 2005 | 90 | 43 | 0.676691729 | 0.775411284 | 0.775411284 | | 0.78205608 |
| 2006 | 64 | 43 | 0.598130841 | 0.750731395 | 0.736269311 | 0.750731395 | 0.750446775 |
| 2007 | 53 | 31 | 0.630952381 | 0.720211284 | 0.688622449 | 0.701734694 | 0.704751995 |
| 2008 | 39 | 33 | 0.541666667 | 0.705334801 | 0.635258317 | 0.674204932 | 0.682612111 |
| 2009 | 39 | 27 | 0.590909091 | 0.681953639 | 0.590249963 | 0.611860405 | 0.640328477 |
| 2010 | 28 | 28 | 0.500000000 | 0.67057307 | 0.587842713 | 0.590414745 | 0.625502661 |
| 2011 | 35 | 20 | 0.636363636 | 0.651620507 | 0.544191919 | 0.565882035 | 0.587851863 |
| 2012 | | | | 0.65009482 | 0.575757576 | 0.567234848 | 0.602405395 |
| | | | | 90% upper CI | 0.703453533 | | |
| | | | | 90% lower CI | 0.448061619 | | |
| | | | MAD | 0.095290899 | 0.081256186 | 0.089628132 | 0.084638486 |
| | | | MSE | 0.012085306 | 0.008160775 | 0.009907483 | 0.009237686 |
| | | | MAPE | 16.28% | 13.75% | 15.65% | 14.29% |
| | | | | | | | Alpha |
| | | | | | | | 0.3 |



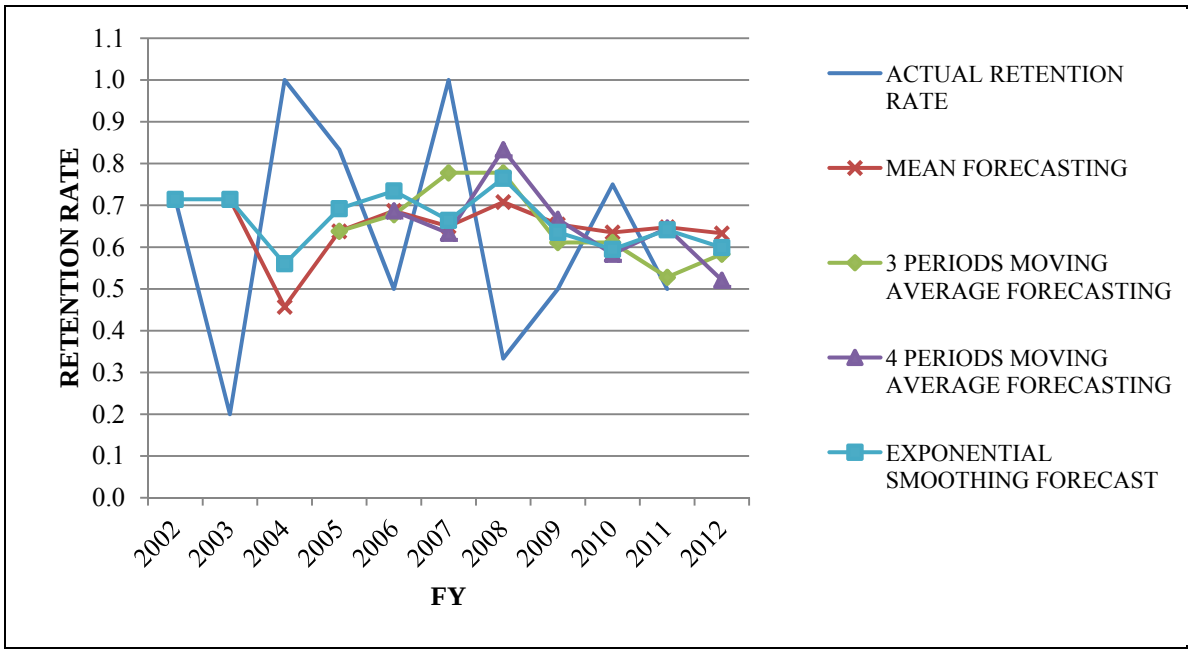
## Internal Medicine Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 41 | 11 | 0.788461538 | | | | 0.788461538 |
| 2003 | 20 | 15 | 0.571428571 | 0.788461538 | | | 0.788461538 |
| 2004 | 29 | 7 | 0.805555556 | 0.679945055 | | | 0.723351648 |
| 2005 | 27 | 6 | 0.818181818 | 0.721815222 | 0.721815222 | | 0.748012821 |
| 2006 | 22 | 10 | 0.687500000 | 0.745906871 | 0.731721982 | 0.745906871 | 0.76906352 |
| 2007 | 15 | 13 | 0.535714286 | 0.734225497 | 0.770412458 | 0.720666486 | 0.744594464 |
| 2008 | 15 | 10 | 0.600000000 | 0.701140295 | 0.680465368 | 0.711737915 | 0.68193041 |
| 2009 | 10 | 10 | 0.500000000 | 0.686691681 | 0.607738095 | 0.660349026 | 0.657351287 |
| 2010 | 11 | 7 | 0.611111111 | 0.663355221 | 0.545238095 | 0.580803571 | 0.610145901 |
| 2011 | 9 | 8 | 0.529411765 | 0.65755032 | 0.57037037 | 0.561706349 | 0.610435464 |
| 2012 | | | | 0.644736465 | 0.546840959 | 0.560130719 | 0.586128354 |
| | | | | 90% upper CI | 0.728707892 | | |
| | | | | 90% lower CI | 0.364974025 | | |
| | | | MAD | 0.129349199 | 0.095760262 | 0.096341356 | 0.109013353 |
| | | | MSE | 0.019913108 | 0.012917767 | 0.01296289 | 0.01634509 |
| | | | MAPE | 21.98% | 16.50% | 17.46% | 18.69% |
| | | | | | | | Alpha |
| | | | | | | | 0.3 |



## Neurologists' Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 5 | 2 | 0.714285714 | | | | 0.714285714 |
| 2003 | 1 | 4 | 0.200000000 | 0.714285714 | | | 0.714285714 |
| 2004 | 4 | 0 | 1.000000000 | 0.457142857 | | | 0.56 |
| 2005 | 5 | 1 | 0.833333333 | 0.638095238 | 0.638095238 | | 0.692 |
| 2006 | 3 | 3 | 0.500000000 | 0.686904762 | 0.677777778 | 0.686904762 | 0.7344 |
| 2007 | 2 | 0 | 1.000000000 | 0.64952381 | 0.777777778 | 0.633333333 | 0.66408 |
| 2008 | 1 | 2 | 0.333333333 | 0.707936508 | 0.777777778 | 0.833333333 | 0.764856 |
| 2009 | 1 | 1 | 0.500000000 | 0.654421769 | 0.611111111 | 0.666666667 | 0.6353992 |
| 2010 | 3 | 1 | 0.750000000 | 0.635119048 | 0.611111111 | 0.583333333 | 0.59477944 |
| 2011 | 2 | 2 | 0.500000000 | 0.647883598 | 0.527777778 | 0.645833333 | 0.641345608 |
| 2012 | | | | 0.633095238 | 0.583333333 | 0.520833333 | 0.598941926 |
| | | | | 90% upper CI | 0.976676537 | | |
| | | | | 90% lower CI | 0.189990129 | | |
| | | | MAD | 0.286839044 | 0.188208617 | 0.255456349 | 0.281047454 |
| | | | MSE | 0.106034372 | 0.049863406 | 0.082700125 | 0.099385252 |
| | | | MAPE | 66.16% | 37.26% | 51.46% | 67.12% |
| | | | | | | | Alpha |
| | | | | | | | 0.3 |

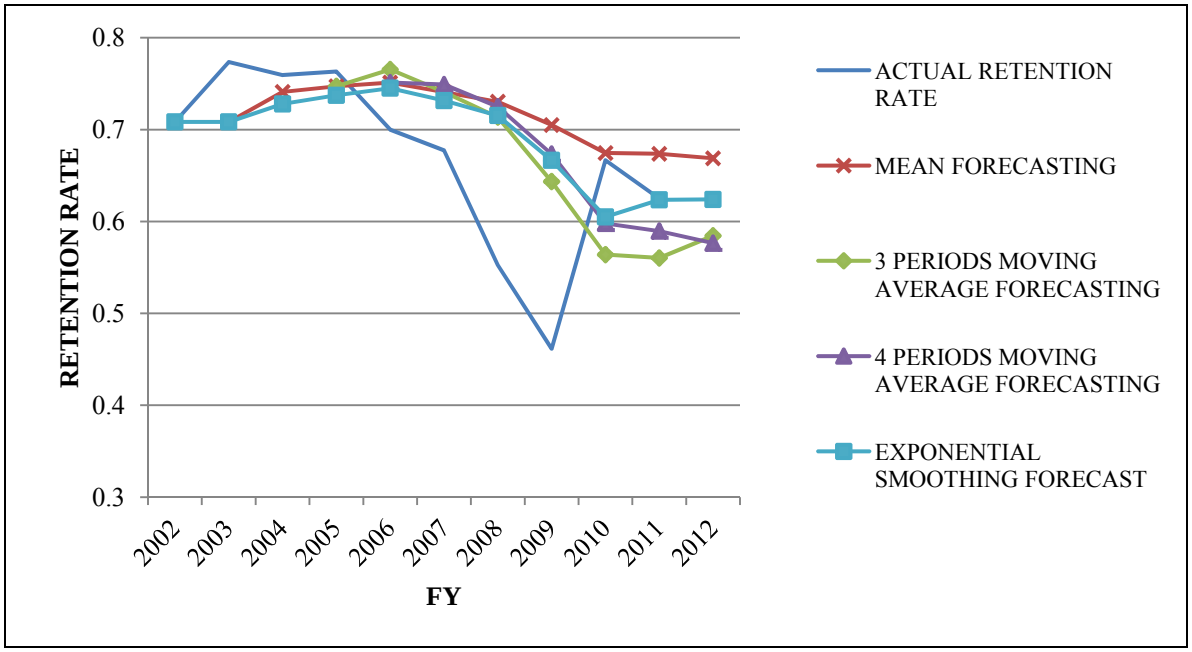


## Pediatrics Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 34 | 14 | 0.708333333 | | | | 0.708333333 |
| 2003 | 41 | 12 | 0.773584906 | 0.708333333 | | | 0.708333333 |
| 2004 | 41 | 13 | 0.759259259 | 0.740959119 | | | 0.727908805 |
| 2005 | 29 | 9 | 0.763157895 | 0.747059166 | 0.747059166 | | 0.737313941 |
| 2006 | 28 | 12 | 0.700000000 | 0.751083848 | 0.76533402 | 0.751083848 | 0.745067127 |
| 2007 | 21 | 10 | 0.677419355 | 0.740867079 | 0.740805718 | 0.749000515 | 0.731546989 |
| 2008 | 21 | 17 | 0.552631579 | 0.730292458 | 0.71352575 | 0.724959127 | 0.715308699 |
| 2009 | 12 | 14 | 0.461538462 | 0.704912332 | 0.643350311 | 0.673302207 | 0.666505563 |
| 2010 | 12 | 6 | 0.666666667 | 0.674490599 | 0.563863132 | 0.597897349 | 0.605015432 |
| 2011 | 10 | 6 | 0.625000000 | 0.673621273 | 0.560278902 | 0.589564015 | 0.623510803 |
| 2012 | | | | 0.668759145 | 0.584401709 | 0.576459177 | 0.623957562 |
| | | | | | | 90% upper CI | 0.782551476 |
| | | | | | | 90% lower CI | 0.465363648 |

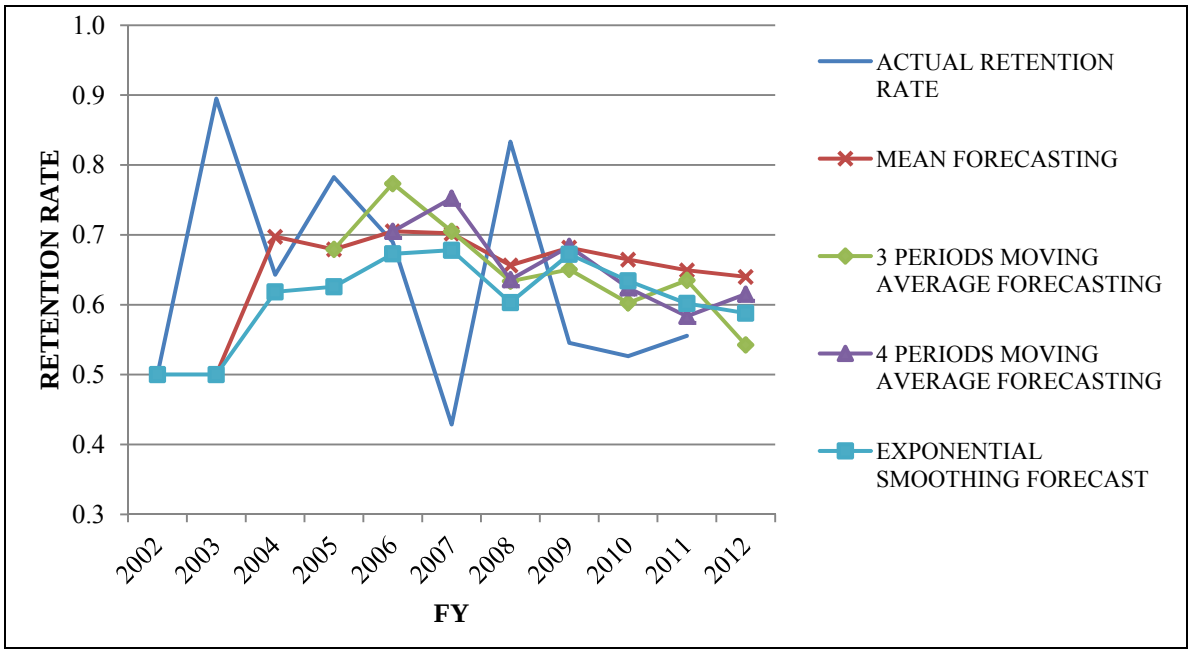
| | | | | |
|---|---|---|---|---|
| MAD | 0.07685133 | 0.093578538 | 0.101826934 | 0.07249171 |
| MSE | 0.011634053 | 0.011749343 | 0.014709836 | 0.009238647 |
| MAPE | 13.72% | 16.44% | 18.49% | 12.63% |

| Alpha |
|---|
| 0.3 |



## Psychiatrists' Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 9 | 9 | 0.500000000 | | | | 0.5 |
| 2003 | 17 | 2 | 0.894736842 | 0.5 | | | 0.5 |
| 2004 | 18 | 10 | 0.642857143 | 0.697368421 | | | 0.618421053 |
| 2005 | 18 | 5 | 0.782608696 | 0.679197995 | 0.679197995 | | 0.62575188 |
| 2006 | 20 | 9 | 0.689655172 | 0.70505067 | 0.773400894 | 0.70505067 | 0.672808924 |
| 2007 | 9 | 12 | 0.428571429 | 0.701971571 | 0.705040337 | 0.752464463 | 0.677862799 |
| 2008 | 15 | 3 | 0.833333333 | 0.65640488 | 0.633611766 | 0.63592311 | 0.603075388 |
| 2009 | 12 | 10 | 0.545454545 | 0.681680374 | 0.650519978 | 0.683542157 | 0.672152771 |
| 2010 | 10 | 9 | 0.526315789 | 0.664652145 | 0.602453102 | 0.62425362 | 0.634143304 |
| 2011 | 10 | 8 | 0.555555556 | 0.649281439 | 0.635034556 | 0.583418774 | 0.601795049 |
| 2012 | | | | 0.639908851 | 0.542441963 | 0.615164806 | 0.587923201 |
| | | | | 90% upper CI | 0.796183384 | | |
| | | | | 90% lower CI | 0.288700543 | | |
| | | | MAD | 0.154074553 | 0.132004092 | 0.133431236 | 0.150354505 |
| | | | MSE | 0.035805525 | 0.022454775 | 0.028925147 | 0.036253819 |
| | | | MAPE | 24.58% | 23.12% | 25.07% | 23.14% |
| | | | | | | | Alpha |
| | | | | | | | 0.3 |

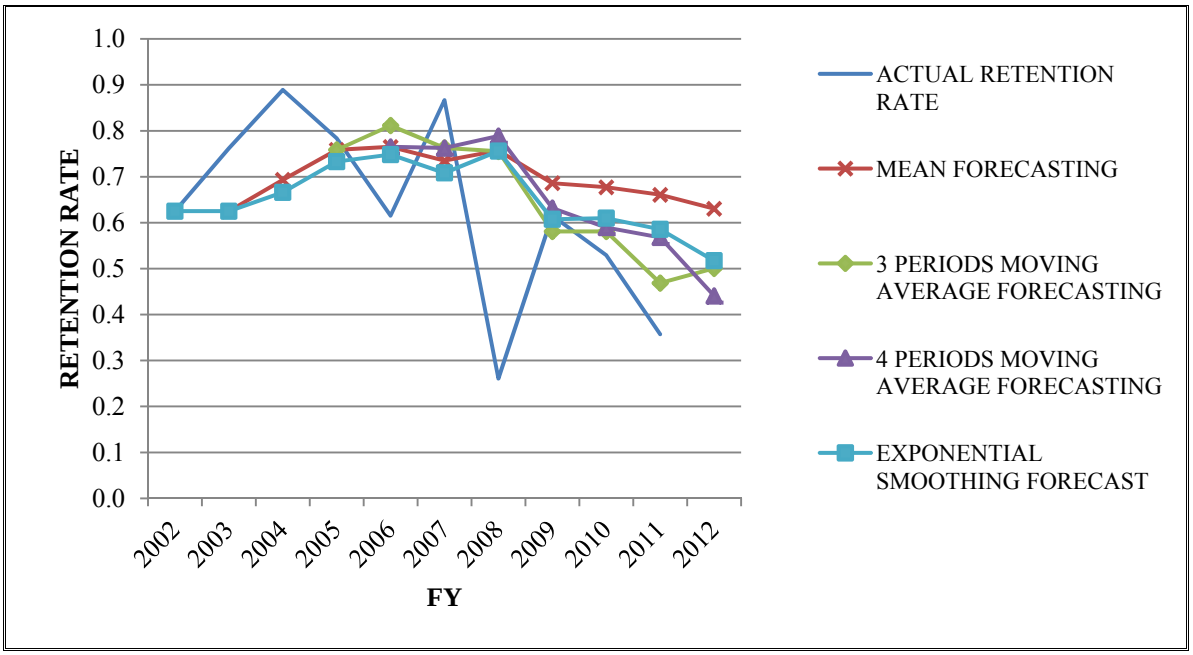


## Radiologists Retention Projection Model

| FY | Stayers | Leavers | Actual Retention Rate | Mean Forecasting | Three Periods Moving Average Forecasting | Four Periods Moving Average Forecasting | Exponential Smoothing Forecast |
|---|---|---|---|---|---|---|---|
| 2002 | 30 | 18 | 0.625000000 | | | | 0.625 |
| 2003 | 32 | 10 | 0.761904762 | 0.625 | | | 0.625 |
| 2004 | 32 | 4 | 0.888888889 | 0.693452381 | | | 0.666071429 |
| 2005 | 29 | 8 | 0.783783784 | 0.758597884 | 0.758597884 | | 0.732916667 |
| 2006 | 16 | 10 | 0.615384615 | 0.764894359 | 0.811525812 | 0.764894359 | 0.748176802 |
| 2007 | 26 | 4 | 0.866666667 | 0.73499241 | 0.762685763 | 0.762490512 | 0.708339146 |
| 2008 | 6 | 17 | 0.260869565 | 0.756938119 | 0.755278355 | 0.788680989 | 0.755837402 |
| 2009 | 8 | 5 | 0.615384615 | 0.686071183 | 0.580973616 | 0.631676158 | 0.607347051 |
| 2010 | 9 | 8 | 0.529411765 | 0.677235362 | 0.580973616 | 0.589576366 | 0.60975832 |
| 2011 | 5 | 9 | 0.357142857 | 0.660810518 | 0.468555315 | 0.568083153 | 0.585654354 |
| 2012 | | | | 0.630443752 | 0.500646412 | 0.440702201 | 0.517100905 |
| | | | | | | 90% upper CI | 0.886327878 |
| | | | | | | 90% lower CI | 0.147873932 |

| | | | | |
|---|---|---|---|---|
| MAD | 0.184106394 | 0.1453003 | 0.17814896 | 0.168174722 |
| MSE | 0.051378935 | 0.044373322 | 0.060028623 | 0.046378911 |
| MAPE | 44.14% | 40.45% | 51.95% | 39.95% |

| Alpha |
|---|
| 0.3 |



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